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COMPLETE R-E 1961 INDEX



Individual Benches
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See page 4

50c

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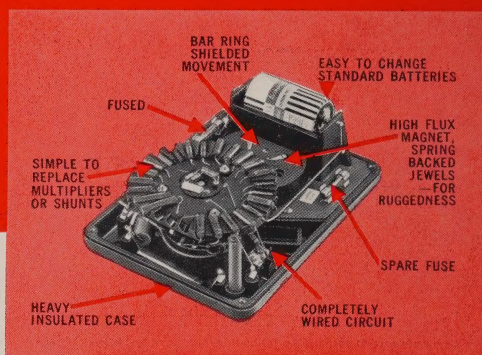
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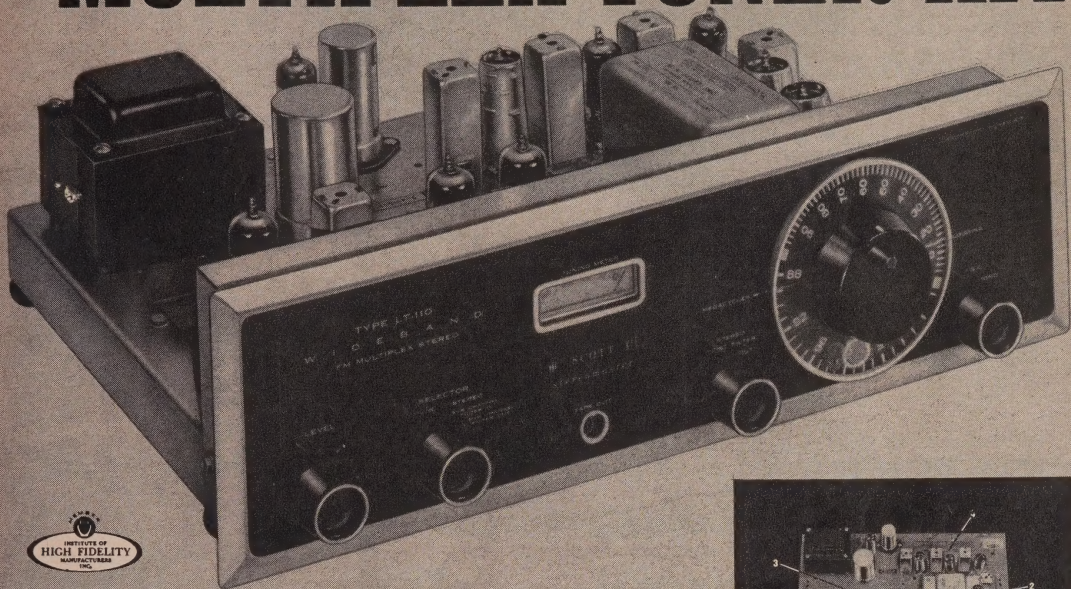
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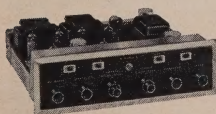
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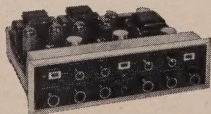
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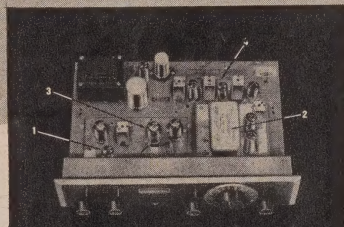
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Radio-Electronics

DECEMBER 1961
VOL. XXXII No. 12

Formerly RADIO CRAFT — Incorporating SHORT WAVE CRAFT — TELEVISION NEWS — RADIO & TELEVISION*

editorial

Hugo Gernsback 29 Lunar Radio and TV Traffic

stereo - audio-high fidelity

- Donald L. Stoner 30 An FM Stereo Multiplex Adapter
2-tube unit you can build over the weekend
- Robert F. Scott 36 Reverberation Enhances Your Hi-Fi Audio
How reverberation systems work
- Jack Darr 52 Old-Timer Helps Replace a Power Transformer,
Part II
- Ronald L. Ives 57 Constant-Setting Audio Volume Control
- Herman Burstein 72 FM Tuner Problem

what's new

55 Pictorial Reports of New Developments

electronics

- James R. Spencer 40 Transistor Roundup
Basic characteristics of 497 types
- 47 What's Your EQ?
(Answers to November puzzles on page 98)
- R. E. Pittet, Jr. 50 Build an Electronic Shooting Gallery
Portable and safe, uses bullets of light
- Martin H. Patrick 74 Make a 5- μ a Relay
Really sensitive unit for those special applications

radio

- Leonard D'Airo 48 Radio Troubleshooting Chart II
Helps you handle those transistor sets
- Dexter S. Bartlett 96 Inventors of Radio—Augusto Righi

industrial electronics

- Tom Jaski 33 Induction Relays and Their Uses
A different type of relay does an important industrial job
- Dellroye D. Darling 46 Anti-chatter Capacitors
Put a stop to relay buzzing
- Ed Bukstein 89 Industrial Electronics Dictionary
From one-shot multivibrator to photoelectric cutoff control

television

- Fred Shunaman 38 New Thought in Service Benches
- Eric Leslie 39 Banana Tube Is Color CRT
New tube uses new principles
- Mike Wayne 51 Snow in the If?
- Jack Darr 61 Service Clinic
When an electrolytic goes bad. . .

test instruments

- Paul S. Lederer 56 Zener-Diode Voltage Calibrator
Calibrate your scope and vtvm with this one unit
- Barron Kemp 58 Full Value from Your Scope
It can be used for more things than tracing a signal
- Wayne Lemons 77 New CB Xmitter Testers
They check power, modulation, standing waves

the departments

- 82 ANNUAL INDEX (Jan.-Dec. 1961)
- 21 Correspondence
- 124 New Books
- 116 New Literature

- 120 New Patents
- 108 New Products
- 100 New Tubes & Semiconductors

- 6 News Briefs
- 98 Noteworthy Circuits
- 54 Shortwave Forecast
- 121 Technicians' News
- 117 Technotes
- 106 Try This One
- 99 50 Years Ago

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(More on page 38)

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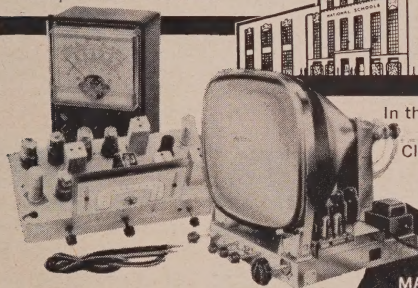
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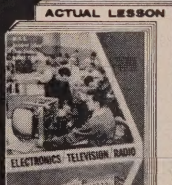
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News Briefs

Practical Ion Engine May Give Us Edge in Space

A working ion engine, demonstrating principles that might eventually send a spacecraft to Mars at 2,000,000 miles a day, was shown to science and technical writers at the Hughes Aircraft Co. research laboratory at Malibu, Calif. Newsmen were shown the engine actually operating in a vacuum chamber which duplicates as closely as possible the conditions which the engine will encounter in space.

Hughes scientists said that an actual test of the engine in space is planned for 1962. Asked how soon we might expect a space ship to make the round trip to Mars, they suggested 1975 or 1980 as a reasonable estimate.

The principles of ion propulsion were outlined in detail by Prof. Hermann Oberth in a two-article series "Electric Space Ships" in *RADIO-ELECTRONICS* in December 1950 and January 1951. Briefly, a propellant, usually cesium, is stored in a reservoir from which cesium vapor is diffused through a hot tungsten element which ionizes the cesium by contact ionization. There then follows a system of electrodes to which voltage is applied to accelerate the ions to a very high exhaust velocity.

Finally, the high-velocity ion beam passes through a neutralizer region in which electrons are injected into the beam to neutralize the positive charge of the cesium ions. It is nec-

essary to emit electrons at exactly the same rate as ions. If only the positive ions were ejected, the spacecraft would become highly charged negatively, until it pulled the ions back to the ship (or the ship back to the ions). It is also necessary, the Hughes scientists explained, that the electrons and ions be intimately mixed very close to the vehicle to neutralize the charge everywhere in the beam. Otherwise, the thrust can be reduced greatly by beam divergence and return of unneutralized portions of the beam to the ship.

The great advantage of the ion engine is economy—it will drive a ship 20 or 30 times as far as will a chemical rocket engine with the same amount of fuel. Its disadvantage is that it does not have enough thrust to get a ship out of the earth's gravity, and thus must have a rocket booster or start from a space platform or satellite.

Computer Talks Back In New Inquiry Device

A device to be used for making train and flight reservations, and for many similar jobs, which gives replies to requests in voice was demonstrated by Remington Rand Univac at the opening of the Univac engineering and research center at Whitpain, Pa.

The unit is expected to simplify and accelerate updating and reporting of changes in inventory, production, distribution and sale. It will also have applications in hotels, auto ren-

tal agencies and department stores.

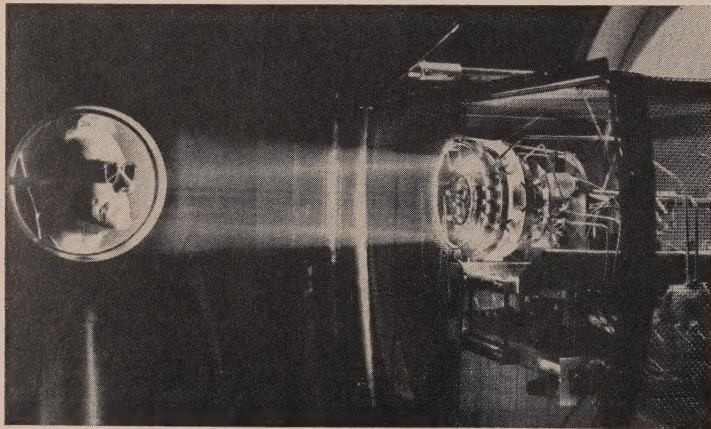
Unicall is attached to an ordinary telephone circuit by setting up levers at the correct points on its face. In the unit demonstrated, intended for airline reservations, the levers could select airline names, types of request (first available space, cancel, etc.), dates and other pertinent data. The user simply pulls the lever down opposite the pertinent abbreviation, number or letter. A button was pressed to transmit the message on tones of the type the telephone company uses in its long-distance dialing systems. The answer "first available space Flight 471, Oct. 14" came back immediately by voice over the telephone. The answering component was Univac's computer at St. Paul, Minn. It had checked available space, then answered with the help of spoken phrases selected from a number stored on its magnetic memory drums.

Because of the machine's speed and the ability of the central computer to handle large numbers of inquiries almost simultaneously, it is to be a low-cost device. Monthly rental of a single unit is expected to cost about \$30, with something less than \$10 of telephone company equipment, plus regular line charges.

Spacecraft Not Germcarriers

The vacuum of space is likely to kill bacteria and fungi, if pressures are low enough and the exposure is prolonged, declares Charles G. Wallace, manager of the Hughes Aircraft Co. components and materials laboratory. Experiments made at the laboratory show that micro-organisms can survive relatively high vacuums, giving rise to the opinion that they can live in space. But if more realistic space conditions were approximated, they were unable to survive. All micro-organisms were killed in a 30-day "flight" at a pressure equal to that about 300 miles above the earth.

Even a shorter flight in real space might be fatal to germs, researchers



Ion engine being tested under simulated space conditions.

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believe. In real space, they would be subject to ultraviolet and other radiation as well as vacuum. At any rate, sterilization of moon rockets is unnecessary. Any surviving microorganisms landing on the moon would be killed by the high vacuum there.

Broadcasting 55 Years Old

Dec. 24, 1961, marks the 55th anniversary of the first radio broadcast. Speech and music were transmitted by high-frequency alternator from Brant Rock, off the coast of Massachusetts, to an audience composed largely of ship operators. Sponsor of the broadcast was wireless pioneer Reginald Fessenden and his National Electric Signaling Co. Fessenden reported on the 1906 broadcast:

"The program on Christmas Eve was as follows: first a short speech from me saying what we were going to do, then some phonograph music. Then came a violin solo by me, a composition of Gounod called 'O Holy Night,' and ending up with the words 'Adore and be still' of which I sang one verse, in addition to playing on the violin, though the singing of course was not very good. Then came the Bible text 'Glory to God in the highest and on earth peace to men of good will' and finally we wound up by wishing them a Merry Christmas and then saying that we proposed to broadcast again on New Year's Eve."

The transmitter was a rotating high-frequency ac generator, operating at about 80 kc. The antenna was an "umbrella" type on a tower 400 feet high.

"Closed-Circuit TV" Across Narragansett Bay

Classroom TV has been extended by the University of Rhode Island to include a classroom at the Raytheon anti-submarine and undersea warfare center at Portsmouth. While the university's on-campus students receive face-to-face instruction, the students across the bay get the same courses through "closed-circuit" television.

The distance between professors and students is about 14 miles. The microwave link operates from the water tower at the university to the Raytheon water tower on its premises at Portsmouth. A "beam bender" on that tower reflects the signal down to a dish antenna mounted on the roof of the building in which classes are held.

Broadcast Pioneer Passes

O. B. Hanson, one of the first broadcast engineers, died Sept. 26 of a heart attack. He was 67 years old.

Deciding on a radio career at an early age, he studied at the Marconi School (now RCA Institutes) in New York City and went to sea as a wireless operator. Later he joined the engineering department of Mar-

coni, becoming chief test engineer in 1918.

During World War I, Mr. Hanson went back to ship wireless operating for a time, and in 1921 joined station WAAM in Newark, N. J., as chief engineer. A microphone of his own design attracted the attention of larger radio stations, and in 1923 he became staff engineer and later plant manager of WEAJ, New York (now WNBC). He became chief engineer of National Broadcasting in 1926 and was elected vice president in 1937. He was elected a vice president of RCA in 1954 and remained in that post till his retirement in 1959. Mr. Hanson was a Fellow of the Institute of Radio Engineers, the Acoustical Society of America and the Society of Motion Picture Engineers.

AES Holds Record Convention

The Audio Engineering Society heard an unprecedented number of papers at its annual convention held in New York City Oct. 9-13. More than 100 papers were read to the over 1,000 audio engineers who attended the convention. The sessions on sound reinforcement, tape and disc recording, and stereo FM drew especially large audiences and created lively discussion.

The society presented its annual John Potts Memorial Award to J. K. Hilliard of the Ling-Altec Research Div. of Ling-Temco-Vought, for pioneering achievement in electro-acoustic transducer design. The Emil Berliner Award was bestowed on Roy Dally, phonograph cartridge engineer of the General Electric Audio Products Div., for achievements in electromagnetic disc reproducing transducer design. The Audio Engineering Society Award was presented to Sherman Fairchild, as the person whose work has most helped to advance the Society during the past year.

Officers of the society for the coming year are H. H. Scott, president; H. E. Roys, RCA Victor Record Div., executive vice president; A. B. Clapper, Universal Recording Corp., Central vice president; Wm. H. Thomas, J. E. Lansing Sound, Inc., Western vice president. C. J. LeBel, Audio Devices Inc., secretary, and R. A. Schlegel, Radio WOR, treasurer.

Do-It-Yourself Ionosphere Is Radio Engineers' Plan

A scheme for creating electrically charged clouds in the region between 40 and 250 miles above the earth and sustaining their charge for hours with radio power pumped from below has been announced by a team of Sperry Gyroscope Co. engineers. The charged clouds would make excellent reflectors that could be used to extend the range of TV stations beyond line-of-sight, to act as midpoint reflectors for long-distance radio relays, and even to substitute for satellites in transoceanic broadcasts.

The Signal Corps has set up an artificial cloud of powdered cesium

carbonate which was used to bounce a 100-mc signal between Texas and Florida. The reflecting patch lasted only a half hour. The Sperry engineers, though silent for patent reasons on the details of their plan, believe they could ionize such a cloud from below without using impractical amounts of power.

No Stereo AM, Says FCC

There is little evidence of public need or desire for AM stereo, the FCC stated in turning down petitions from Philco, RCA and Kahn Research Laboratories, who wished to see standards established for an AM stereo system.

An AM stereo system with sufficient separation and without bad side effects would be much harder to realize than was the case with FM, the commission pointed out. Also, the pattern of operation and the needs and purposes served by the nearly 4,000 AM stations are such that the beneficial effects of such an innovation as stereo would be small.

Rf Breaks Rocks

Radio frequency can break up rock as effectively as explosives and can be as much as 25 times as economical according to a recent test report from General Electric.

The new process depends on the often-overlooked fact that "solid" rock contains as much as 5% water. Trapped in the crystalline structure of the rock, it can be reached and heated by electricity. A source of high-energy rf is applied to the rock through electrodes. Once a current-carrying path is established, it reduces the internal resistivity of the rock, making it possible to increase the power. The resulting heat, or "thermal stress," splits the rock along the path of conductivity.

General Electric estimates that a source of current in the 20-40 mc range with a power output of about 25 kilowatts will be suitable for a commercial rock-breaking system. The practical feasibility of the process was tested by General Electric in cooperation with the Montana School of Mines.

Radar "Angels" Have Wings

The "angels" on radar screens—those mysterious blips that have puzzled scientists and radar operators for years—are (as ornithologists have suspected for a number of years) migrating birds. This solution of a 20-year-old problem was proposed by three ornithologists in the October, 1961, issue of *Natural History*, a publication of the American Museum of Natural History. In experiments on the coast of Massachusetts, filters designed to remove objects the size of migrating birds filtered the "angels" out completely.

Besides solving a puzzle that was first posed when British operators noted the strange blips on their

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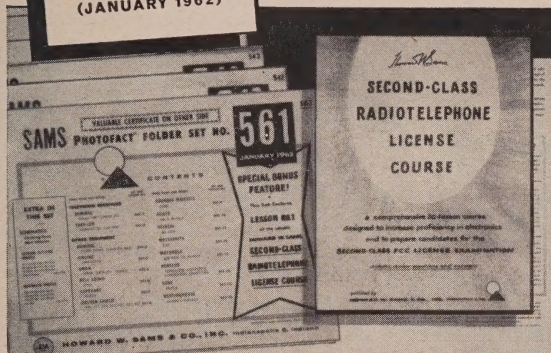
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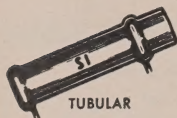
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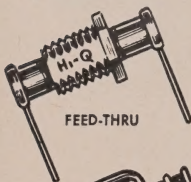
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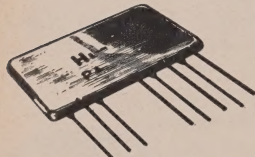
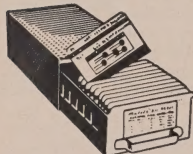


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screens in 1940 and 1941, the scientists believe they have added a new tool in the study of bird migrations. Already they have discovered that the actual patterns of migratory birds are often quite different than they appear to a ground observer.

Calendar of Events

EIA Winter Conference Nov. 28-30 Statler Hilton Hotel, Los Angeles, Calif.

IRE Conference on Vehicular Communications, Nov. 30-Dec. 1, Hotel Radisson, Minneapolis, Minn.

IRE, AIEE, ACM Eastern Joint Computer Conference, Dec. 12-14 Sheraton Park Hotel, Washington, D.C.

National IRE, AIEE, ASOC and EIA Symposium on Reliability and Quality Control, Jan. 9-11, Statler Hilton Hotel, Washington, D.C.

ERA Annual Convention, Jan. 23-27, Hollywood Beach Hotel, Hollywood Beach, Fla.

Copper Hairs Into Space

A 75-lb. air force instrument package spewed three hundred and fifty million tiny copper hairs into orbit around the earth Oct. 21. Arranged in a band 2100 miles up, the little wires, about a third the thickness of a human hair and only 0.7 inch long, are expected to act as tiny dipole antennas for reflecting radio signals. Tests of 8,000-mc signals between radar antennas at Parks Air Force Base in California and Millstone Hill, Westford, Mass., via the copperwire belt will be made during the anticipated 3-year useful life of the particles.

Klystron Inventor Killed

Sigurd F. Varian, co-inventor of the klystron tube, was killed in a recent plane crash in the Pacific about a mile off the coast of Mexico. Mr. Varian, with his late brother Russell and Dr. William Hansen, founded Varian Associates in Palo Alto, Calif., to develop and manufacture microwave components. The klystron tube, developed as a detector of microwaves in 1939, led to the development of microwave radar as one of the vital weapons in the defense of Britain during World War II.

Third Consol Station Coming

The Federal Aviation Agency announces that it is installing a Consol station at Miami, Fla. Consol is the principal long-range radio navigation aid operated by the FAA serving air traffic outside the United States. It and Consolan (RADIO-ELECTRONICS, March 1961) are two forms of the same system, a direction-finding technique that requires only a radio tunable to its frequency and a Consolan chart.

There are two earlier Consolan stations in the United States, one at Nantucket and one at San Francisco. Besides being used by planes, small-boat owners find them valuable. One use in marine navigation, for example, is to aid commercial fishermen. Nantucket fishers report that they put out their pots along a radial of the Nantucket Consolan, and are able to retrieve them easily by going back along the same line.

END



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Completion of the Master Course (both Sections) will prepare you for a First Class Commercial Radio Telephone License with a Radar Endorsement. Should you fail to pass the FCC examination for this license after successfully completing the Master Course, you will receive a full refund of all tuition payments. This guarantee is valid for the entire period of your enrollment agreement.

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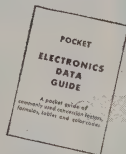
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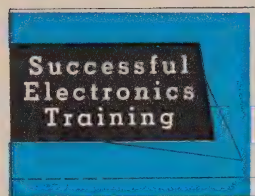
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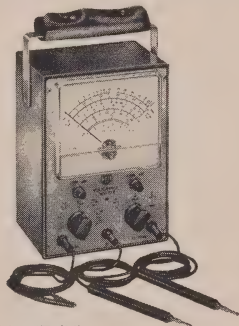
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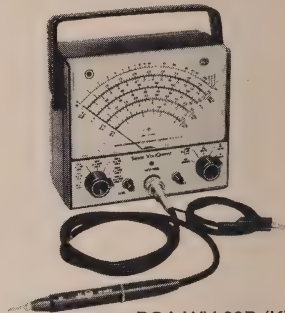


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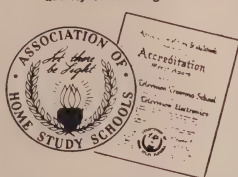
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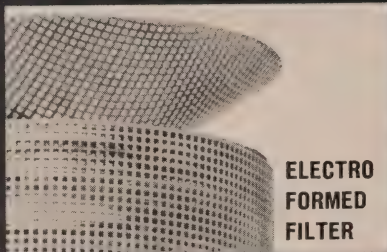
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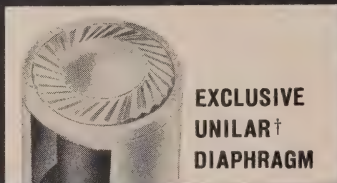
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- ☐ You can get your First Class FCC license **IN ONLY 12 WEEKS** in Grantham resident classes (or, in a correspondingly short time in the Grantham home-study program). **THINK OF IT!** A commercial U.S. Government license...**PROOF OF YOUR** qualifications in meeting these U.S. Government requirements as an electronics communications technician...a nationally recognized certificate. By preparing you for this license in only 12 WEEKS, Grantham conserves **YOUR TIME!**
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Darrell E. Cloce, 25 E. 32nd St., Kansas City, Mo.	1st	12
P. B. Jernigan, Route 2, Benson, North Carolina	1st	12
Claude Franklin White, Jr., c/o Radio Sta. WJMA, Orange, Va.	1st	12
John M. Morgan, c/o KIRI-TV, 1530 Queen Anne Ave., Seattle, Wash.	1st	9 1/2

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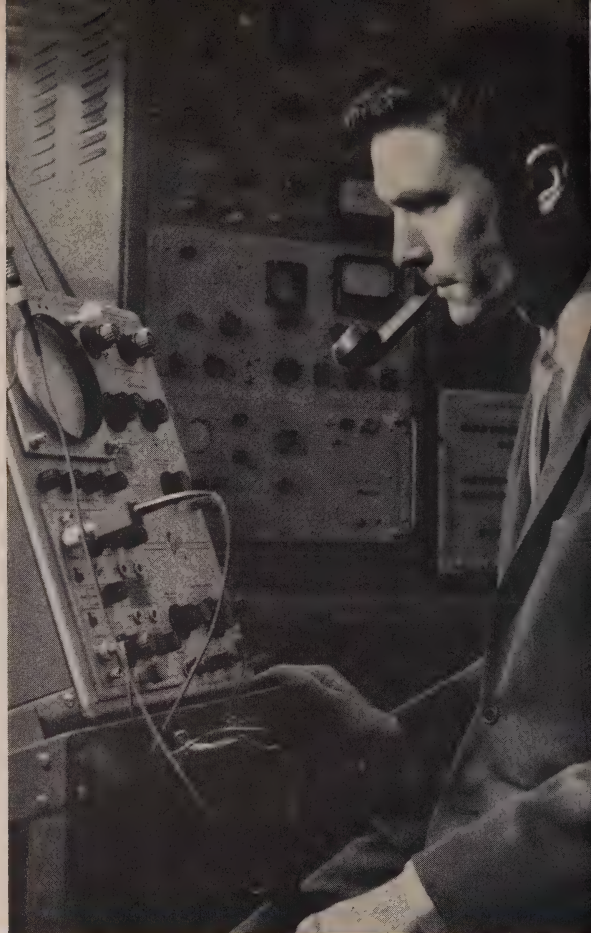


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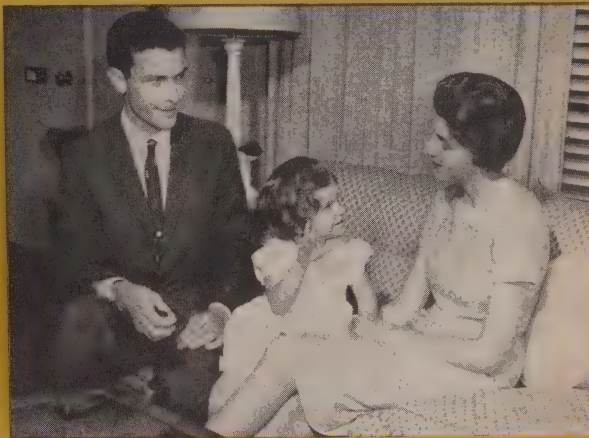
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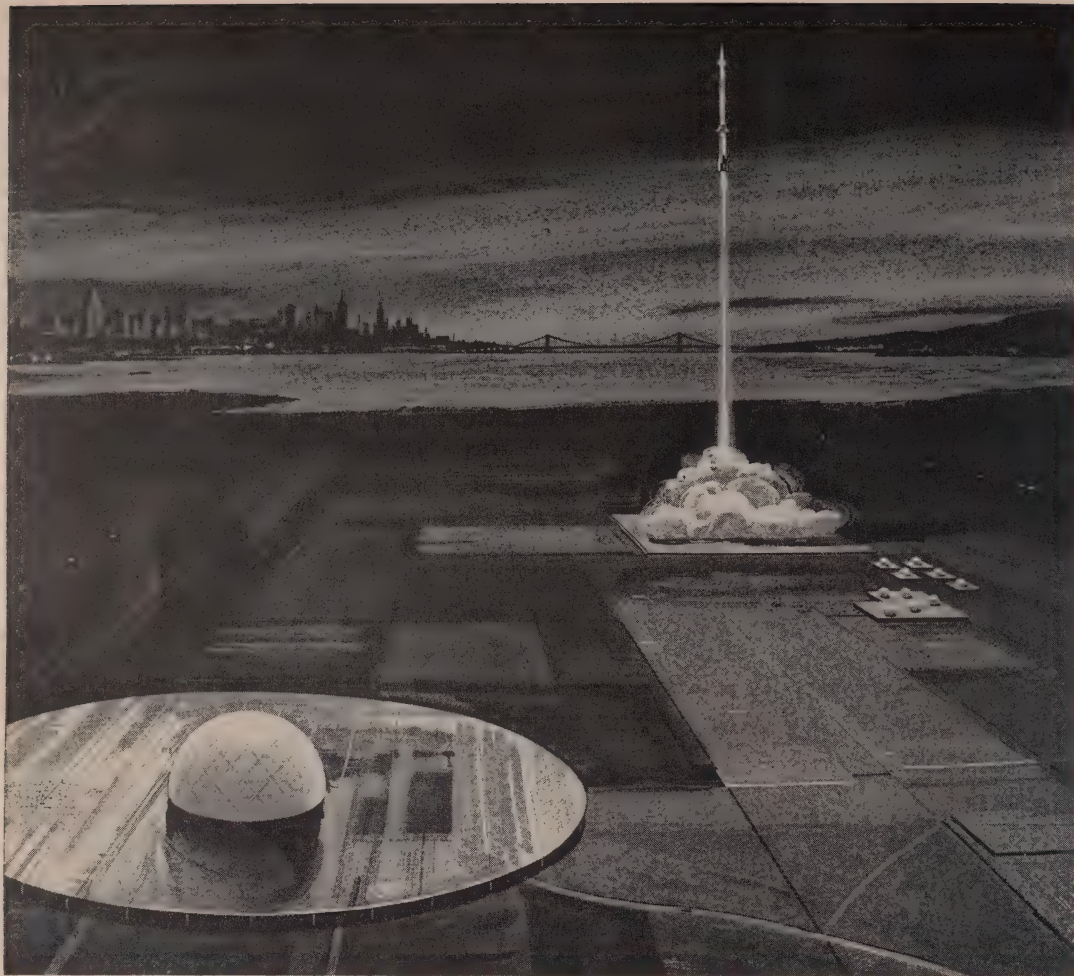
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The system tracks the ICBM or IRBM, then launches and tracks the Nike Zeus missile and automatically steers it all the way to intercept the target. The entire engagement, from detection to destruction, would take place within minutes and would span hundreds of miles.

Under a prime Army Ordnance contract with the Western Electric Company, Bell Laboratories is charged with the development of the entire Nike Zeus system, with assistance from many subcontractors. It is another example of the cooperation between Bell Laboratories and Western Electric for the defense of America.

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BUILDING ELECTRONIC CIRCUITS on specially-designed plug-in type chassis, is the work of Robert H. Laurens, Hammon, N. J. He is an Electronic Technician working on the "Univac" computer. Laurens says, "My NRI training helped me to pass the test to obtain this position."



"I OWE MY SUCCESS TO NRI" says Cecil E. Wallace, Dallas, Texas. He holds a First Class FCC Radio-telephone License and works as a Recording Engineer with KRDL-TV.



MARINE RADIO OPERATOR is the job of E. P. Searcy, Jr., of New Orleans, La. He works for Alcoa Steamship Company, has also worked as a TV transmitter engineer. He says, "I can recommend NRI training very highly."



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Correspondence



COMPETITION VS. COMPETENCE

Dear Editor:

A New York-to-Miami vacation trip in mid-August with two young children kept my eyes on TV nightly. Mostly on a different receiver each evening.

The one constant thing in almost all locations was the poor condition of the TV receivers in most motel rooms. In all too many cases, one was left with a poor impression of the service technician's competence. Defects more commonly found were poor raster linearity, misadjusted hold, age and size. Some of these can easily be attributed to tube aging and line-voltage variations. Others, such as a tilted raster, can only be blamed on sloppy servicing.

The worst examples were found in a Florida town where local distributors have discount sales limited to authorized service organizations.

The enforcement of this policy is so strict that local electronic manufacturer(s) allow their employees to purchase tubes and components from the company stock. An accounting system makes deductions from the payroll. Special parts usually require a 100-mile round-trip to another city.

One thought immediately comes to mind—which came first: poor service or strict regulation? Since the system has been in effect for several years, poor service should have disappeared long ago, if the claim that restriction would keep incompetents and tyros out of the field were true. Apparently what has happened is that competition has been strangled to such an extent that the quality of service is not a competitive quantity any more.

ELMER C. CARLSON

New York, N. Y.

INVENTOR STRIKES BACK

Dear Editor:

The August issue's News Briefs on "How Cathode Heats in 1/10 Second" may describe a new fast-heating tube, but the cathode's 1.6 volts is not "the closest approximation to the unipotent cathode yet achieved in a filament."

Way back in the mid-Twenties, Western Electric produced the VT-1 at about 1.5 volts; RCA produced the WD-12 tube which worked very well below 1.5. (See my Sept. 22, 1926, paper before the Radio Club of America, and the March 1927 issue of *Radio Broadcast*.) About this same time, the Armstrong Co. of Newark, N. J. produced

my "AC 100 Tube," with a straight, oxide-coated, nickel filament operating at 0.7 to 0.8 volt and about 2.5 amperes, and usable in the detector stage of a radio receiver because of its very low ac hum.

This tube was described and demonstrated before the Radio Club of America at Columbia University on May 18, 1927, and published in its *Proceedings* later and also in *Radio Broadcast* for September 1927.

The very low voltage-effect hum of this tube was neutralized by its magnetic-effect hum (180° out of phase) at a filament voltage of about 0.7. Its heavy, high-thermal-inertia (nickel) filament reduced its temperature modulation, at double the ac energizing frequency, to the vanishing point. About 6 months after this tube appeared on the market (and was scoffed at by RCA and others of the Patent Pool), RCA brought out a 1.5-volt ac tube (the 226) using the same principles of hum suppression, and a few years later they bought my entire portfolio of socket-powered radio patents and some 22 outstanding licenses.

Your news item's last "cuts hum" statement is hard to believe. Those "very fine" filament wires of the harp cathode will surely have a strong 120-cycle temperature and emission modulation, which neither their voltage-effect nor magnetic-effect hums can possibly neutralize, because they are out of phase with both.

The magnetic fields of these wires, which deflect their electron streams to the plate into longer paths for each half-cycle of their currents will also produce hum, unless carefully balanced against their voltage-effect hum by design and by rated voltage specifications for all electrodes.

BENJAMIN F. MIESSNER

Miami Shores, Fla.

ELECTRONIC IGNITION NOT FOR ME

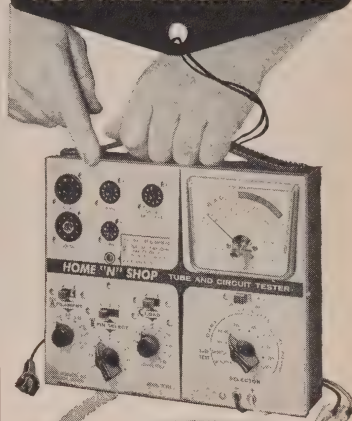
Dear Editor:

I was rather surprised to see an article like "Electronic Ignition For Your Car" in the September 1961 issue. Admittedly, a transistorized ignition system is a fine project worthy of discussion if it is properly designed. However, proper design involves, among other things, the use of as simple a circuit as possible that will do the job efficiently and reliably. How can a little black box that contains 1 transformer, 2 transistors, 12 resistors, 8 rectifiers, 7 capacitors, 1 thyatron and a thermal relay be considered simple or reliable? There are too many parts to malfunction.

As if this weren't enough, there is a Rube Goldberg buzzer "quick start" and, when this produces undesirable side effects, you file off the leading edge of the distributor rotor. Such articles would be better left to the electronics sections of one of the backyard mechanics magazines. J. S. PITMAN

[This is the second letter of this type we have received this week.

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Unfortunately, you seem to be judging a system you have not built or tried and are guessing at its probable performance. This is not enough. I tried and tested the system. It works and works well, despite the "large" number of parts you quote. Incidentally, the common ac-dc table radio has many more parts than this ignition system, yet it regularly operates for years without needing repairs. If you scale this down, the ignition system should work for decades. It's got fewer parts to go wrong.

The quick-start buzzer is not a Rube Goldberg device. It works and works well. If you or any other reader can suggest a better method, we'd be happy to learn of it. If filing down the distributor rotor (I didn't have to) is necessary, it's no different from adjusting the gap on a spark plug so the plug functions properly.

What has been overlooked is that the electronic ignition system has definite advantages over mechanical systems. Better and surer firing, better gas mileage and better pickup and high-speed operation are examples. Also, plugs last longer and points do not pit as rapidly when an electronic ignition system is used.

As a final point, these "complicated" electronic systems are often used in race cars. Here, where a system really gets a workout, they are not considered too prone to failure to make them impractical, so why should they be impractical for your car?—Larry Steckler, Associate Editor]

WRONG CONTROLS

Dear Editor:

The "Quality Stereo Preamp" by W. R. Williams that appeared in the October 1961 issue should prove a worth-while do-it-yourself project for the nimble-fingered home builder.

Mr. Williams was kind enough to use Centralab controls and lists part numbers for purchasing ease. However, the types he lists for R31 and R32 are not correct. The "B" controls he indicated have solid 1/4-inch shafts and cannot be used as part of a dual concentric assembly. The parts that should be specified are: R31, 1 megohm, 500,000-ohm tap, linear taper (part F1-56). R32, 1 megohm, 500,000-ohm tap, linear taper (part R2-56).

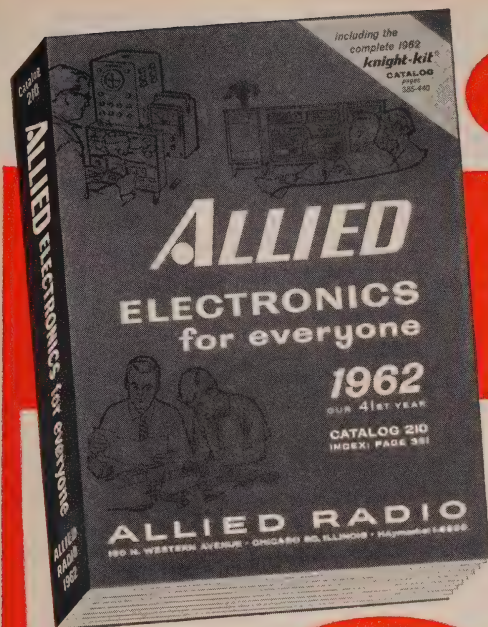
For additional ease in construction, may we suggest using our SR-70 stereo-twin control for R34. It will eliminate the need for soldering stiffeners between R32 and R34. Unfortunately, we cannot provide a simpler solution for soldering the shaft of R33 to the rear of R31.

We have made up a list of the correct parts numbers along with the suggestion for simplifying the assembly of the loudness control for the benefit of any of your readers who may desire it.

R. E. ANDERSON

Merchandising Assistant
Centralab
Milwaukee, Wis.

END

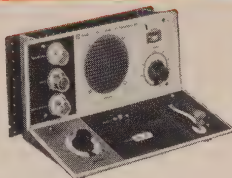


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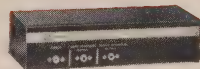
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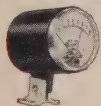


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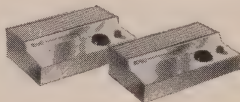


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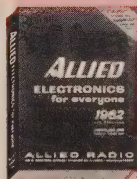
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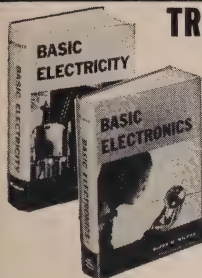
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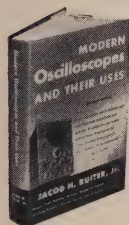
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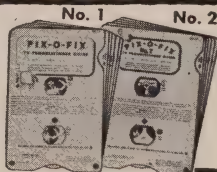
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TONGUE

MATV

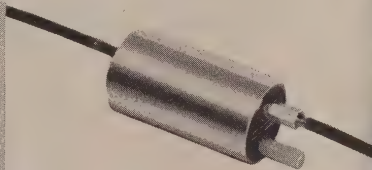
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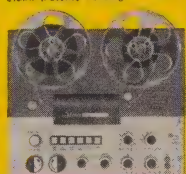
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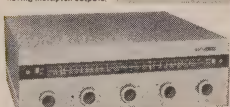
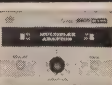
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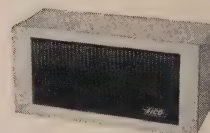
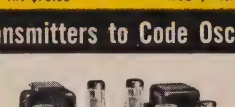


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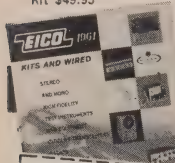
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LUNAR RADIO & TV TRAFFIC

... The Moon Poses New Problems for Electronics ...

ON May 25, 1961, President Kennedy, in a special message to Congress, officially proposed that the country—at a cost of \$20 billion—send a man to the moon and back by 1970. Congress has endorsed this plan by voting a \$1.7 billion budget for the space agency this year. The total US moon expenditure may reach \$40 billions, particularly if the program is speeded up, which it well may be.

Since we, as well as the USSR, are now committed to the conquest of the moon (which we soon will people with our nationals), we should look ahead to the years to come.

Neither we nor the Russians are making these moon trips as pleasure excursions. Tremendous practical stakes are involved. To begin with, the moon is the best space station we may have for a long time. From it we can take off for other planets at a vastly reduced energy cost, because the moon's gravitation is only a sixth that of the earth. Thus a 1,000-ton spaceship weighs only 166 tons on the moon, and the energy to launch it into space is only one-twentieth that required on earth.

We will find the most precious and strategic metals, from platinum to beryllium, in great profusion for transshipment to earth in unmanned, radio-guided transports. Mining will be comparatively simple because of the low lunar gravity.

Most of the great optical telescopes will be on the moon where, because of the absence of an atmosphere, visibility is 100% as against 60% on earth. These telescopes will be operated by remote control from earth, and observation will be via TV and resident observers. Similar electronic means will be used for radio astronomy.

As the population of the moon increases and as industries proliferate, radio communication with the earth, spacecraft in transit and electronically guided unmanned transports will multiply at a vast rate. The moon will always depend chiefly on communication with the earth, and all such electronic traffic must be as free as possible from interruption, despite occasional solar storms and other types of interference. Solar disturbances particularly will require new evaluation of our transmitting and receiving techniques in view of our lack of experience in transmitting a dense electronic traffic to and from the moon across the 238,857-mile vacuum of space. In time it probably will be possible to augment radio and TV communication with extra-narrow-band optical-Maser type transmission and reception.

As the moon always exposes the same geographical face to the earth, which turns constantly, radio and TV transmission and reception presents a problem. Ordinarily, moon messages meant for the US could not be received 24 hours a day via direct line of sight, because parts of our western hemisphere will be invisible from the moon for 12 hours in a given day. Such messages, received in the eastern hemisphere, would then have to be relayed from there to the US. Earth messages to the moon are similarly handicapped. They will have to be relayed to a country that faces the moon or be delayed until the earth has turned around again.

Fortunately, by the time the moon is opened up, most messages will probably go via artificial earth-communication satellites which we will put up during the next few years.

While they have not been originally designed for lunar messages, there is still time to change their construction slightly so that moon traffic can be relayed to earth via the 50-odd satellites which we will put into orbit soon.

One of the slight inconveniences that man will have to put up with—probably forever—will be the time lag between earth and moon circuits. Radio waves take 1.2 seconds to bridge the 238,857 miles. Hence, when phoning to the moon, 1.2 seconds must elapse for a one-way communication to speed to its destination, and a like time for the answer—a total of 2.4 seconds. This makes for a somewhat slowed-up conversation, but will probably not be too annoying.

Delay becomes serious with a similar conversation to the planet Mars. Here the total elapsed time is 2 minutes and 10½ seconds for a one-way message; 4 minutes 21 seconds for a two-way conversation. Consider also that this timing is possible only during "conjunction" of the two planets—35 million miles. At the greatest separation, 248 million miles, the time for a two-way message would be almost 31 minutes!

Coming back to moon communications, let us also consider that the moon will be peopled not only on its always visible side as we see it from earth, but also on the far side that man never sees directly. That means that we have to take measures to relay the messages to the visible side opposite the earth. We cannot erect radio transmitters on the back side of the moon to communicate with us directly, because the signals would go out into space, never reaching the earth. Hence they must be relayed around the moon to transmitters located opposite the earth. Because there is no ionosphere on the moon, lunar radio transmissions must, it seems, rely on ground waves rather than on reflected waves. Short-range radio relay systems, or very-long-wave systems relying on ground-wave transmission, may be the answer.* This, provided that the moon's upper strata is conductive. We shall not know about this until we have actually contacted the moon, either by robot or manned craft.

Consider the technical aspects and the vastly increased quantity of all the various types of electronic transmission, which in less than 10 years will have multiplied greatly on earth. Then add a new large load to and from the moon. It becomes quite apparent that new techniques must be evoked if the interference and heterodyne problems are not to choke all electronic communication. Even today there is a great deal of chaos on many frequencies.

In addition we have the nuisance problem of "strays" or RFI—radio-frequency interference—which often plays havoc with scores of electronic instruments.

It would seem that before long entirely new means of safeguarding the transmission of radio messages, particularly long-distance signals such as those to and from the moon, will have to be invented. It presents a difficult and complex problem in electronics, but we are certain it will be solved.

—H.G.

*See also "Radio on the Moon," RADIO-ELECTRONICS, July 1959.

Merry Christmas — Happy New Year — The Editors

The new stereo FM multiplex system is causing a surge of activity in the FM and hi-fi industry. Manufacturers are busily producing multiplex adapters and integrating this system into complete stereo receivers. The experimenter, too, will be interested in building his own multiplex adapter. It isn't too difficult and can be easily completed on a weekend. It will work with most wide-band FM tuners. If you live in a city with one or more FM stations, check to see which outlets are planning to provide this new service. By the end of the year many stations will be equipped to broadcast stereo FM programs.

This adapter will work with all FM tuners that have a wide-band discriminator or ratio detector. However, it requires an input of at least 0.4 volts. If the input signal is lower the 38-kc oscillator may not lock. At no time should the input signal be greater than about 2 volts. If it is, the L + R signal will ride through with the oscillator signal and cause severe distortion.

articles "Clear Road for FM Stereo" in the August, and "Stereo FM from Your Own Tuner" in the September issue of this magazine.

A stereo adapter

Fig. 1 is the circuit of a simple two-tube adapter. The MULTIPLEX output of the FM receiver is plugged into J1, the adapter's input. V1-a, half of a 12AU7, amplifies this composite information. The amplified composite signal appears across plate load resistors R9, R10, and is coupled to SEPARATION control R3, through C3, a 0.47- μ f capacitor. This control adjusts the L + R amplitude in the matrix, and is set for greatest separation of the left and right channels. Coil L1 is a low-pass filter which attenuates all frequencies above 15 kc. Resistor R4 terminates this network and L1's output is fed to the matrix.

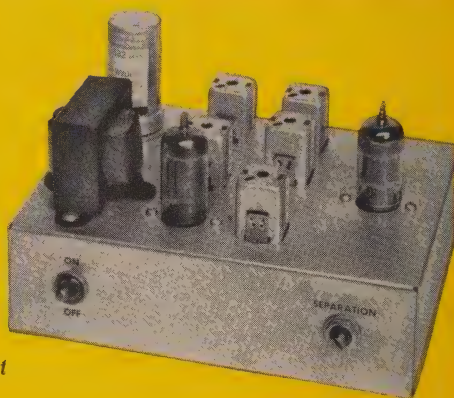
From the plate of V1-a, the composite signal is fed to V1-b, also a 12AU7 triode. The subcarrier signal is also taken off V1-a's plate at the junction of R9 and R10 and is fed through filter network L2, L3 and on to the matrix. The 19-kc pilot signal is taken off

synchronous detector from the plate end of L5's primary. Series resistor R19 and capacitor C15 set the level of the re-inserted carrier. The secondary winding shown in coil L5 is not used. In an earlier version it was hooked up, but distortion was higher.

The amplitude of the subcarrier sidebands is reduced slightly to insure that they feed the matrix with exactly the same amplitude as the main-channel information. This is done by tapping the 23- to 53-kc bandpass network down on the plate load of V1-a. Coil L2 is a series-tuned circuit that is resonant at approximately 48 kc. Note that a capacitor is connected across this series combination to provide an anti-resonant frequency. The frequency of the null in the response that results from this combination is set to 67 kc, the SCA (subsidiary communications authorization) frequency. If this is not done, the second harmonic of the 38-kc subcarrier will beat with the 67-kc subcarrier and produce an annoying 9-kc whistle. The second coil in the bandpass network, L3, resonates around 38 kc and has a rapid attenuation curve below 23 kc. The re-

BUILD AN FM STEREO MULTIPLEX ADAPTER

Two-tube unit is easy to put together, works with most wide-band tuners



Basically the system processes the stereo sources as left and right channels. The signals are combined so that L + R modulates the main carrier in a conventional manner. The L - R signal is used to amplitude-modulate a 38-kc subcarrier. After generating the sidebands, the subcarrier is suppressed and its remaining sidebands also modulate the main channel. A 19-kc pilot subcarrier is generated to phase-lock the re-inserted subcarrier in the receiving adapter.

In the receiver, the detector output consists of the L + R audio, the 19-kc pilot subcarrier and the 23- to 53-kc L - R sidebands. Filters separate these sidebands in the adapter, and a 38-kc signal (locked to the 19-kc pilot) is used to recover the original L - R information. The L + R main channel and L - R information is combined in a matrix to separate L and R at the two output terminals. For a more detailed explanation of this complex processing, see the

V1-b's plate and coupled to a tap on oscillator coil L4. [Note the wiring at this point. There are two possible connections here. With tuners that have a fairly high output (1 volt or more) use the connection which bypasses C14 and uses the capacitor built into the coil. However, with low-output tuners this arrangement will give you a critical and narrow locking range. If you find the locking range narrow and critical use the alternate hookup with C14 and bypass the capacitor built into the coil.] The coil, which is resonated by C11, acts as a low impedance to all frequencies other than 19 kc, and filters that frequency out effectively. Triode V2-a is the 19-kc electron-coupled oscillator and is synchronized by the pilot subcarrier fed to L4. The output of this stage is resonated at the oscillator second harmonic (38 kc) by coil L5. The plate is, in effect, tapped down the coil to provide more efficient doubling action. The 38-kc subcarrier is fed to the

BENCH



TESTED

A member of the staff of RADIO-ELECTRONICS was present when this unit was tested at an electronics laboratory. The test results showed that good separation was obtained to at least 12 kc, decreasing somewhat above this frequency. However, even at 15 kc, the highest frequency that will be transmitted during an FM stereo broadcast, separation was satisfactory. Inputs between approximately 0.4 and 2.0 volts produce a satisfactory stereo effect. The unit was also tested "in the home" with an actual FM stereo signal. Again results were satisfactory.

sponse curve produced by these two coils is relatively flat between 23 and 53 kc and separates the subcarrier sidebands from the remaining information.

The subcarrier sidebands and the reinserted carrier feed the junction of diodes D1 and D2 connected to produce demodulated signals of opposite phase. D1 rectifies an L-R signal while D2 rectifies the -L+R half of the subcarrier. Thus the L-R signal from D1 results in L being in phase with the L+R main channel but R is out of phase. Therefore the signal at jack J2 is for the left channel. Diode D2 produces a -L+R signal. Therefore L is out of phase with the L+R main channel but R is in phase. Thus the output from J3 represents the right-channel signal.

The power supply is conventional and uses the remaining 12AU7 triode as a rectifier. Although this service exceeds the heater-cathode rating slightly, dozens of hours of operation indicate that

it is not harmful. A 100-ohm 1/2-watt resistor (R11) protects the rectifier against surges. A multi-section electrolytic insures a minimum of ripple on the B-plus line. A small 1-to-1 isolation type power transformer eliminates any shock hazard from the ac line. If desired a 100-ma silicon diode rectifier could be used here. If you do this, use a 6C4 single triode for V2. It has the same

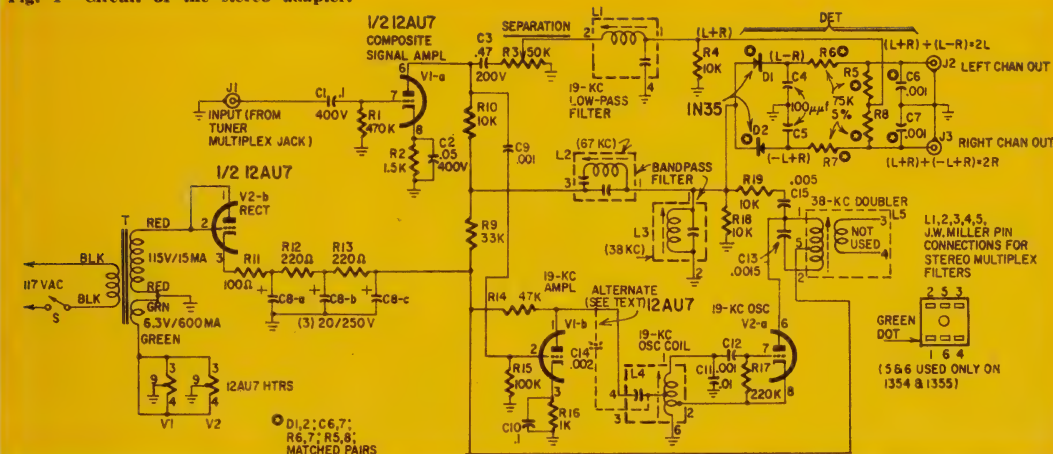
characteristics as a half of a 12AU7.

The pin connections for the filter coils are shown in Fig. 1; they are numbered clockwise from pin 1 (green dot). Pin 5 is inserted between 2 and 3, while pin 6 is on the opposite side between pins 1 and 4. The pin connections and coil numbers must be observed faithfully or it will not be possible to make the adapter work properly.

R1—470,000 ohms
R2—1,500 ohms
R3—pot, 50,000 ohms, linear taper
R4, R10, R18, R19—10,000 ohms
R5, R6, R7, R8—75,000 ohms, 5% (preferably matched, see text)
R9—33,000 ohms
R11—100 ohms
R12, R13—220 ohms
R14—47,000 ohms
R15—100,000 ohms
R16—1,000 ohms
R17—220,000 ohms
All resistors 1/2-watt 10% unless noted
C1—0.1 μ f, 400 volts, paper
C2—0.05 μ f, 400 volts, paper
C3—0.47 μ f, 200 volts, paper
C4, C5—100 μ f, disc ceramic
C6, C7—0.01 μ f, disc ceramic (preferably matched)
C8—20–20–20 μ f, 250 volts, electrolytic
C9—0.01 μ f, disc ceramic

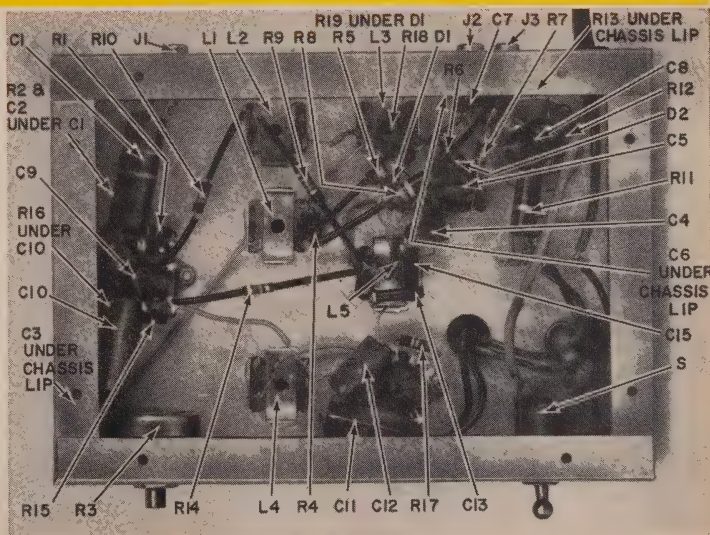
(Sprague TVL-3532 or equivalent)
C10—1 μ f, paper
C11—0.1 μ f, silver mica
C12—0.01 μ f, silver mica
C13—0.0015 μ f, silver mica
C14—0.02 μ f, disc ceramic
C15—0.05 μ f, disc ceramic
D1, D2—1N35 or similar matched diodes (see text)
J1, J2, J3—phono jacks
L1—19-kc low pass filter (Miller No. 1351)
L2—bandpass filter (Miller No. 1352)
L3—bandpass filter (Miller No. 1353)
L4—19-kc oscillator (Miller No. 1354)
L5—38-kc doubler output (Miller No. 1355)
S—push toggle
T—power transformer: primary 117 volts; secondary, 115 volts, 15 ma; 6.3 volts, 600 ma (Triad R-54X or equivalent)
V1, V2—12AU7
Chassis, 5 x 7 x 2 inches
Miscellaneous hardware

Fig. 1—Circuit of the stereo adapter.



STONER MULTIPLEX ADAPTER

A printed-circuit board with the necessary printed-circuit tube sockets is available from Donald Stoner, Box 7388, Alta Loma, Calif., for \$5 postpaid. If you have trouble getting the coils for this unit, a kit including printed-circuit board, sockets and coils is available for \$16.



Careful neat wiring is vital if you want an adapter that really works.

There is one feature this adapter does not have. There is no provision for switching from the multiplex output (for stereo broadcasts) to the regular tuner output (for mono programs). Doing this takes the adapter out of the circuit when it is not in use. This prevents it from having any effect on mono programs. There are two ways of adding this feature. One is shown in Fig. 2. Here the tuner's regular outputs are connected to the tuner input on the amplifier. The multiplex output from the tuner is connected to the adapter input. And the adapter outputs are connected to the auxiliary inputs of the amplifier. Now, on mono programs you switch the amplifier input selector to TUNER and for stereo FM to AUXILIARY.

A second way of handling this problem is shown in Fig. 3. This system is necessary if your amplifier does not have a pair of auxiliary inputs. Here you need a three-pole double-throw rotary switch (Mallory 3243J), a phono jack (J4) and a length of coax cable (about 6 inches). When this circuit is installed and the switch placed in the MONO position the regular tuner output is connected to the adapter's output jacks. At the same time, B-plus is removed from the adapter. In the MX (multiplex) position B-plus is reconnected and the tuner's multiplex output is connected to the adapter input.

Building the unit

Construction details of the adapter are shown in the photographs. No part of the circuitry appeared to be critical in any of the several models built.

The coil cans are mounted by scribing the mounting hole on the chassis, drilling within the outline and filling. This is a tedious task, to say the least, and it might be better to purchase K-Tran adapter mounting plates. A printed-circuit board will also eliminate this problem.

Input and output jacks are mounted on the rear apron while the SEPARATION control and ON-OFF switch are on the front.

There are a few precautions regarding component selections. The capacitors associated with V2-a (C11, C12 and C13) must be good-quality silver micas to prevent oscillator drift, which would result in poor separation. Resistors R5, R6, R7 and R8 should be 5% units. If you have access to an accurate ohmmeter or bridge, match R5 to R8 and R6 to R7. The exact value is relatively unimportant. The diodes should also be matched. If possible obtain a ready-matched pair known as type 1N35-A. If these are not available, measure the forward resistance of several germanium diodes and select two with the closest resistance. The capacitors in the matrix are not quite so important although, if C6 and C7 are grossly mismatched, high-frequency separation will be degraded.

Final adjustments

You will need a tunable audio generator, an audio vtm, an oscilloscope and a wide-band FM tuner to align the

stereo multiplex adapter. Warm up the newly completed adapter for approximately 10 minutes, then make the voltage comparison measurements as shown in the chart. A vtm was used to get these readings. Set the SEPARATION control for minimum separation (slider at grounded end). Connect the audio oscillator to J1 and set the generator frequency to 38 kc. Connect your scope to the junction of D1 and D2 and set the level to 0.1 volt. Adjust coil L3 for a maximum. The peak will be very broad and you may have to look closely to see it. Next move the generator to 67 kc and adjust coil L2 for a null.

The null will be very sharp and you should have no difficulty seeing it. Recheck L3 at 38 kc; there is some interaction. Next set the generator to 19 kc and reduce the output to .03 volt. Switch the scope from internal sweep to external input and connect the horizontal input to the audio oscillator. It is difficult to predict what you will see, but the trace will probably be a green square or rectangle, depending on the scope adjustment. Slowly adjust L4 until the pattern suddenly locks to a figure-8 trace, indicating synchronization with the 19-kc pilot and a 2-to-1 frequency ratio. Adjust L5 for maximum vertical deflection which corresponds with maximum output of the 38-kc carrier generator.

For the remaining setup steps, connect the adapter to an FM tuner. Tune

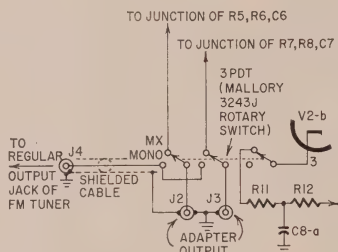


Fig. 2—Switching arrangement takes the adapter out of the circuit when it is not in use.

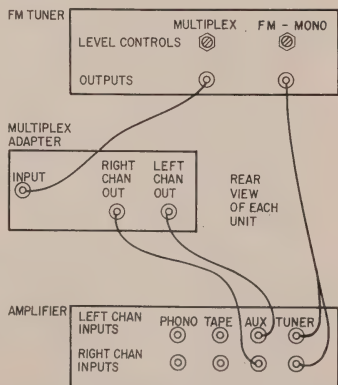


Fig. 3—Hook up your adapter in this fashion and you need only turn the selector switch on your amplifier to place it in circuit.

MULTIPLEX ADAPTER VOLTAGE CHART

no signal	V1	V2
pin 1—50 vdc		100 vac
pin 2—0		100 vac
pin 3—1.6 vdc		124 vdc
pin 4—6.3 vac		6.3 vac
pin 5—6.3 vac		6.3 vac
pin 6—60 vdc		120 vdc
pin 7—0	neg.	-8.7 vdc
pin 8—2.3 vdc		0
pin 9—ground		ground

in a station transmitting SCA (Subsidiary Communications Authorization) commercial music services. This can be determined by looking at the audio coming from the multiplex jack. It will have fuzz on the trace, indicating subcarrier components. Move the scope to the junction of D1 and D2 and make sure the separation control is still off. The fuzz on the audio should be considerably less at this point. Adjust L2 for minimum fuzz. Reason for repeating this step with a station signal is that your audio generator may not be entirely accurate.

Last, but by no means least, you need a stereo multiplex station to set L1, L4 and the SEPARATION control "on the money". Connect the adapter to two amplifiers and tune in a multiplex broadcast or test transmission. If L4 is not synchronized, you will hear a "phut-phut-phut" sound in the speakers. The speed of the motorboat indicates how far off 19-kc your generator is. Readjust L4 until the sound slows down and stops.

The remaining adjustments can be made while listening to a stereo multiplex broadcast. The stereo effect is most noticeable when listening with headphones.

Coil L1 can only be set for best separation with a stereo test signal and an oscilloscope. It is adjusted for the best null of the unwanted channel. However, in practice the adjustment is very broad and the slug can be set in the middle of the two extremes. Even when the slug is set for minimum or maximum inductance, the separation is degraded by less than 3 db.

Next, turn the separation control fully counterclockwise. In this position the main (L + R) signal is grounded out. Now the only output you will hear is the difference signal (L - R) and this will be heard only when a station transmitting a stereo multiplex signal is on the air. When a multicast is on adjust coils L4 and L5 for the clearest undistorted sound. (This will not sound normal, but you will be able to tell when it is undistorted.) At this point they are correctly set. If you find more than one coil position that gives you clear sound, use the one that gives the most volume.

Then adjust the separation controls for best separation. (This is best done when a station is broadcasting test tones.)

END

INDUCTION RELAYS

AND THEIR USES

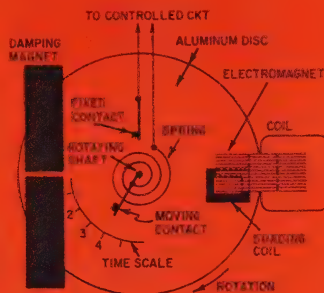


Fig. 1—The basic induction relay principle.

Fifth article in a series on relays and how they work

By TOM JASKI

In previous articles we have examined many types of relays, their circuits and applications. One important class was mentioned only briefly—induction relays. In industry, they play an important and indispensable role. Induction relays guard all large power-generating machinery, virtually all large transmission lines, large power transformers and the huge motors of the heavy industries. You will find them in steel mills, paper mills, oil refineries and chemical factories, aluminum plants and a host of other heavy industrial installations.

Fig. 1 shows the basic construction of the simplest induction relay. It consists of a rotating disc, usually aluminum, which moves between the poles of a shaded electromagnet and the poles of a permanent magnet. The forces created by the shaded magnet, being out of phase, tend to rotate the disc because of the eddy currents and resulting magnetic field generated in the disc. The permanent magnet provides damping.

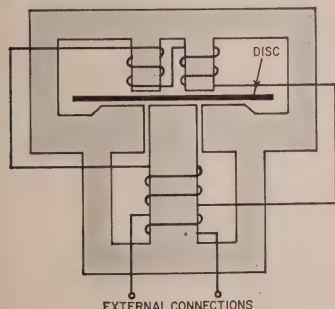


Fig. 3—Practical induction relay magnet structure.

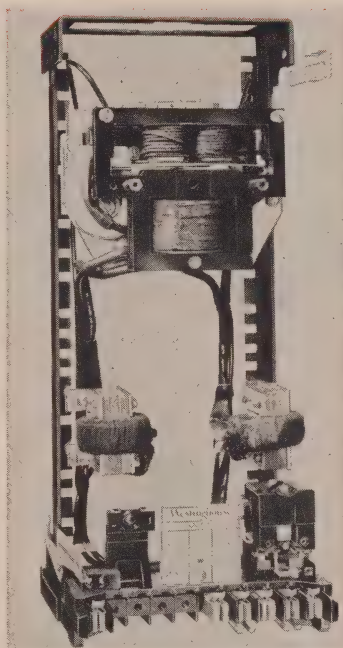


Fig. 2—A typical induction relay. Note time scale at top of relay-rotating disc.

If the disc were not restrained by a spring, it would rotate continuously, like the disc in the watt-hour meter in your home. In an induction relay, the disc carries the relay contacts. By controlling the amount of rotation required to make the contacts close and the rotating speed of the disc, we can accurately time the relay. We can also accurately preset the amount of current required to close the contacts. Generally, induction relays have a fixed relationship between current and time, most often an inverse time-current curve.

The simple relay shown in Fig. 1 has some odd kind of time-delay curve, and actual relays are more complicated than this.

Fig. 2, a typical induction relay, is only one of many varieties. Induction relays are specially made for many functions. They can detect and act on overcurrent, overvoltage, undervoltage, over- and underfrequency, differential currents, phase faults, ground faults, asynchronism, current direction, current balance, temperature and impedance. Special forms discriminate between faults nearby and faults at a distance. It is impossible to discuss all these varieties here, so we will confine ourselves to representative types.

Induction relays may be single-, two-, or three-phase units. The type used depends on the function. If we are concerned about something which may happen in each phase separately, such as overcurrent, we use a single-phase relay. If we need a signal from two or three phases, as in directional relays which check the direction in which power or current is flowing, we use a polyphase type. On a relay panel you often see relays mounted in groups of three. This often, but not always, means

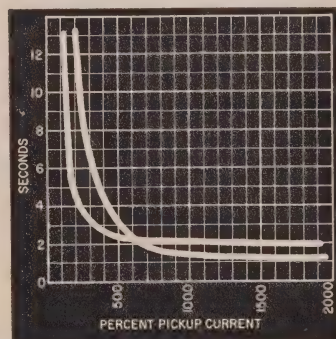


Fig. 4—Typical inverse time-current curves of induction timing relays.

that they are all single-phase relays mounted together for three phases.

In contrast to the simple diagram of Fig. 1, Fig. 3 shows the more usual form of induction-relay magnetic circuit. The main pole has two coils. One is connected to an external source. The other is in series with the coils on the upper poles. This magnetic construction provides the desirable inverse time-current curve available in this kind of relay. Fig. 4 shows some typical curves of that type. They show that, if the current applied to the relay is small, the time for closing is long; if the current is large, the relay closes fast. Of course, there is a limit beyond which no increase of speed can be obtained. This point lies near the synchronous speed—the speed at which the disc would rotate in a fully energized magnet structure and without restraints. Since the disc may rotate over quite an angle (for precision timing), it may require too much contact travel. To avoid this, the contacts are activated by a geared shaft driven by the disc. The curves in Fig. 4 are for such a geared relay.

Kinds of induction relays

The induction principle is also used in another way. If we provide any motive force, and make this rotate a disc which is restrained by a damping magnet, so that time is consumed in rotating the disc, the induction in the disc by the damping magnet delays the closing of the contacts. Such a relay is shown in Fig. 5, the Westinghouse type JD timing relay. The motive power is supplied by the clapper of a clapper type relay structure which drives the disc through a rack and pinion. Thus this relay produces a delay on both energizing and de-energizing. Note the time scale on top of the relay structure. The time is set by changing the position of the stationary contacts. Another version, the ratchet type, has a delay only on energizing.

Still another type of induction relay is shown in Fig. 6. This frequency relay can operate on either an overfrequency or underfrequency. Its structure is similar to that in Fig. 3, but it is so designed that normally there is a certain phase angle between the upper and lower poles. At 60 cycles, this phase difference is enough to provide a torque for the disc. But when the frequency changes slightly (as little as 0.1 cycle at 60 cycles), the phase angle changes and the disc drops back, opening contacts. This opening of contacts can be translated by other relays and control devices into a decreased load on the generator or a speed increase to correct the frequency difference.

The frequency of a power system is extremely important to an industrial community. If it drops by even a little, power is lost in motors. Devices (such as clocks) which depend on synchronism in the system (to run at a precise rate) lag.

Another frequently encountered relay (not an induction type) is the adjust-

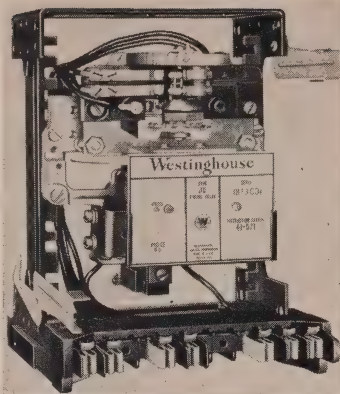


Fig. 5—This timing relay uses induction principle only for timing function. Disc is powered through clapper relay.

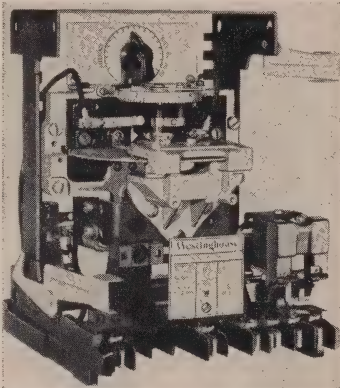


Fig. 6—Interior of frequency-sensitive relay.

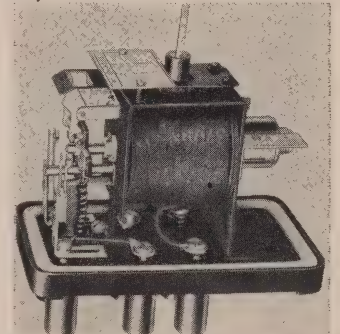


Fig. 7—Common industrial relay which, though not an induction type, uses magnetic shunts to adjust pickup and drop-out times.

able pickup or dropout general-purpose unit shown in Fig. 7. These are adjusted by magnetic shunts that regulate the pickup power of the coil. Where the induction timing relay can be set for delays of as much as 5 seconds (1 or even 0.5 second are more common), this relay provides a maximum delay of 0.17 second. A companion relay which looks almost exactly the same is sensitive to voltage rather than cur-

rent, as far as time delay is concerned.

Besides the various time-delay and special relays, there are many simple clapper type relays. Induction relays, because of their construction are necessarily limited in the number and size of their contacts and, when heavier currents must be handled, an auxiliary relay is included in the circuit.

The most common induction relay is the one whose magnet structure is shown in Fig. 3. It is a simple overcurrent relay, and you can see how it functions. If the relatively low overcurrent persists for very long, the relay contacts close. If a heavy momentary overcurrent occurs, the relay contacts close rapidly. But if the current fluctuates, with momentary but moderate overcurrents, such as might happen in a machine tool, the relay will do nothing. It is set for whatever momentary overcurrents are to be tolerated.

A relay that must operate on two or three phases has several induction magnet structures on one frame, with the required number of discs and a common shaft. But you may find a strange-looking arrangement with four rather than three magnet structures. For example, in a phase-balance relay, where information of all three phases is needed, three structures are arranged to obtain this information. Two of them are opposed on one disc on the shaft, and the third is opposed by the fourth, also on a common disc on the same shaft. The fourth magnet is inserted in either of the other two phases. It simply provides a check (balance) for the third magnet. Current-balance relays may be built in this manner, or provided with special coils or a special magnetic structure in which two coils oppose each other in terms of magnetic field.

Relays at work

Next let us see how these relays are used.

The most common relay application is the overcurrent relay. This applies to just about any electrical device, but particularly power equipment. Fig. 8 shows a simple arrangement of overcurrent relays that are set up to protect a generator against a differential current. Note first that the relay is connected through a current transformer. The current transformers used in power machinery are usually simply a single bus (half-turn) surrounded by a core which carries the secondary winding. Secondaries are almost always arranged to provide 5 amperes. *Never* leave the secondary of a current transformer open on a bus, because extremely high voltages could be induced in the windings, ruining the transformer. When not in use, keep the current transformer shorted or have some standard load on it—a resistor or sometimes a coil.

Note next that currents from these transformers are arranged in opposition, so that, if precisely the same current goes into the winding as comes out at the other end, nothing happens. But if there is a difference in the cur-

rent at the two ends of the winding, something is bound to be wrong and the relay trips. To protect the generator completely against differential faults, three such relays would be needed. Current from one current transformer obviously would protect only one phase against overcurrent.

More common for differential protection is a special differential relay. The circuit for one of these is shown in Fig. 9.

A current transformer can be used for more than one relay. A single one often supplies current to a number of relays or meters. However, for the sake of accuracy, meter current transformers are usually kept separate, and you might see several current transformers per phase. If you take a close look the next time you pass a reasonably large substation structure, you may see current transformers mounted on it.

Often current transformers alone cannot do the trick and we need information about voltage. Since power equipment almost always operates at high voltages (2,300 volts and up), special units called voltage transformers or potential transformers are needed for the voltage information. Potential transformers are practically always built to produce 120 volts. Sometimes the potential transformer is called a control transformer. This name sticks if it is used for relays only.

A normal system load is inductive to a certain extent, and the voltage leads the current. (We say the system has a power factor of less than 1.) This can easily be distinguished from a situation where the current leads the voltage. This would be a capacitive load, one that would return power rather than absorb it. In the case of a generator, this must be avoided. A relay that depends on a phase difference in its magnetic structure can easily be designed to take advantage of such a phase sensitivity, and this is done for the power-directional relays.

This situation is illustrated in Fig. 10. Here a power-directional relay is connected to a generator. Of course, it will need the appropriate current and potential transformer. Note that the potential transformer need be only a two-phase one for the three-phase situation. The transformer will produce a voltage in accordance with what happens on three phases anyway. This is called an *open-delta* connection. Note also that, since voltage and current are operating a directional relay, the proper connection of the transformers is important. A reversal of one would make the relay function oppositely.

Large and important (and expensive) generators are protected against more than just overcurrent, differential and power direction. Usually such problems as frequency, over- and undervoltage, loss of field, lack of synchronism with the system, temperature rise and others are handled by relays. So are current and phase balance, grounding and other kinds of possible troubles. Transmission-line terminals, which usually con-

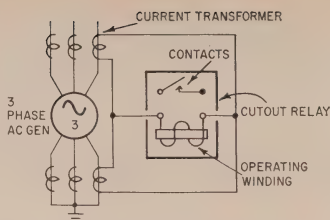


Fig. 8—Simple differential protection of one generator winding with overcurrent relay. Only one phase is shown.

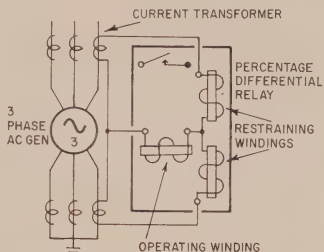


Fig. 9—Special differential relays for generator winding protection. Similar protection is provided for large motors and transformers.

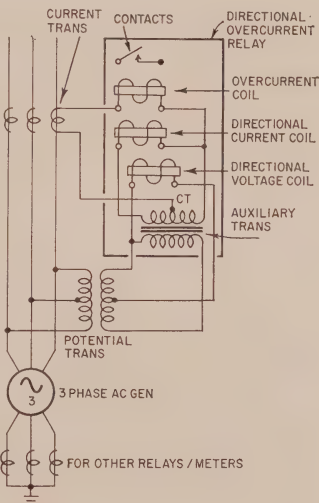


Fig. 10—Directional and overcurrent protection for a generator. Again, only one phase is shown.

sist of large power transformers or at least bus systems, are protected against faults such as phase shorts, grounds, surges and open lines. All these faults activate the relays, which then trip large circuit breakers. The circuit breakers in turn very rapidly (within 3 cycles) take a generator off the line or isolate a section of transmission line, or whatever is required to protect equipment, system and consumer.

What about electronics?

Because many of the functions re-

quired of induction relays can readily be performed electronically, one would expect electronics to have taken over a large portion of the work of induction and other protective relays. This is not so. First, induction relays are older than electronics. Second, they have been on the job for many years with complete satisfaction. In other words, they are reliable and have proven themselves thoroughly. Third, in many places it would be difficult to coordinate a new electronic relay with existing ones. Finally, most induction relays function for many years without any attention. They are virtually maintenance-free. Electronics, before the advent of the transistor, was certainly not to be trusted over many years without attention. There were always filament burn-outs, etc. Now that transistors are an important factor we may see a change in the picture.

Certain functions have been entrusted to electronics in modern relays. There are now phase-comparison relays which use coincidence tubes, frequency-control relays which use tuned circuits and magnetic amplifiers, and some impedance-sensing relays. But the main stumbling block for many years has been cost. To match the accuracy and reliability of magnetic relays, electronic units would be much more expensive. The simpler the magnetic relay, the less economically feasible it is to replace it with electronics. Very complex relays may be the first ones replaced.

But there is continuous impetus for electrification. Many relays are now used with carrier systems. These may be either wire type carriers which use the power line for signal transmission, or microwave radio carriers. Increasing numbers of remote controls in the power-generating industry are being handled by microwave carrier. Naturally, if the control of large systems can be entrusted to electronic transmission, objections to reliability begin to fade drastically. Power engineers are necessarily conservative. Codes, rules, regulations and general practice in the power industry have made them so because of the heavy responsibilities to the industry they serve. Reluctance to replace something tried and true with something new and comparatively unproven is only natural.

END



Uhm—Don't you think that's overdoing it just a bit?

REVERBERATION

ENHANCES YOUR HI-FI AUDIO

Adds that concert-hall feeling to your records

By **ROBERT F. SCOTT**

TECHNICAL EDITOR

AROUND THE MIDDLE OF 1960, SEVERAL manufacturers of packaged audio equipment began featuring reverberation or controlled echo effect in some of their models. Now, a number of manufacturers are distributing reverberation units that can be added to existing audio systems.

Basically, reverberation is produced by passing a part of the program signal through a delay line and then mixing it electronically or acoustically with the undelayed signal.

Some manufacturers, musicians and hi-fi purists consider reverberation units short-lived distortion-producing gimmicks. Others point out that artificial reverberation is used by all major recording studios (for pop records) and that many listeners find that adding a variable amount of reverberation enhances the overall sound. No matter which side of the question you take, these add-on reverberation units and those used in RCA, Philco, Hoffman, Motorola and other hi-fi systems will have to be installed and serviced. They exist, in fair quantities, and continue to be sold in greater numbers than one might imagine.

Add-on reverberation units are of two basic types. Utah, Calbest, Heath, Lafayette and Radio Shack tap off a part of the program signal from the voice-coil terminals of the radio, phonograph or hi-fi system and use a separate amplifier and speaker to reproduce the delayed signal. They are described in this article.

The second type, which includes the CBS, Fisher, Knight and Sargent-Raymont devices, has the delay circuitry shunted across a section of the signal path in the audio system. A portion of the program signal is tapped off, passed through the delay line and then mixed with the undelayed signal in a following stage. A variable control sets the amount of delayed signal fed to the mixer to control the reverberation effect. These units will be covered in a following article.

Why add reverberation?

When listening to a recording of a favorite selection, we can't help noticing that it doesn't sound exactly like the same group performing live at Symphony Hall or in an intimate night club. We have also noticed that a group will sound different out of doors in the

Hollywood Bowl, Lewisohn Stadium or at Newport from performance in a concert hall.

At a live performance we hear the original undistorted sounds "flavored" milliseconds later by multiple reflections from walls, ceiling and other surfaces at various distances from our ears. These reflections continue to bounce around the hall and back to our ears for a noticeable period after the original sound has stopped. This delayed reflection of the original sound is reverberation or echo. Variations in reverberation characteristics can cause the same performers to sound different in different locations.

The amount of reverberation we hear depends on the volume level of the original sound and on the hall acoustics. The duration of the reverberation is the time it takes to drop below the noise level or threshold of hearing. If a particular passage or note is loud, it takes longer for the reverberation to die away than when it is played at a lower level.

Thus, a concert hall with acoustics best suited for band performances might be unsatisfactory for chamber-music groups that usually play softly.

Reverberation gives dimension to sounds that we hear and enables us to visualize the size of a room, even when blindfolded. For years, performers and recording engineers have known that a certain amount of reverberation enhances a performance or recording. When a recording is made in a location with little or no reverberation, they have added artificial reverberation to enhance the reproduction.

Whether or not a recording sounds like the original depends largely on the acoustics of your listening area. If the room is small and sound is absorbed by drapes, rugs and furniture, you may need the additional controlled reverberation available from these new units to give you concert-hall realism.

How reverberation units work

To provide reverberation we must

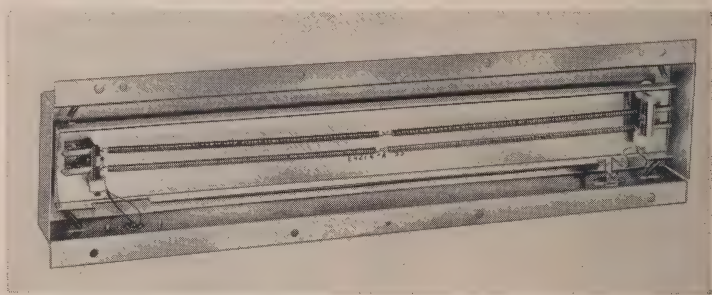


Fig. 1-a—Inside view of basic reverb unit developed by Hammond Organ.

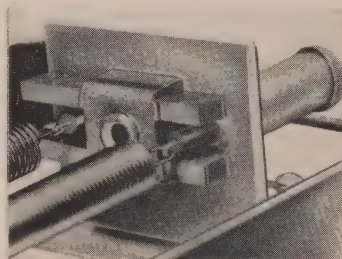


Fig. 1-b—A closeup view of input transducer.

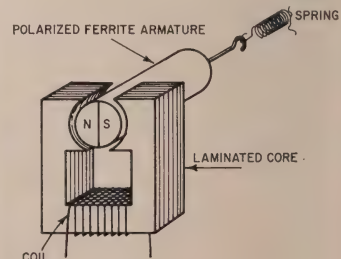


Fig. 1-c—Rotor detail. It turns like a D'Arsonval meter armature.

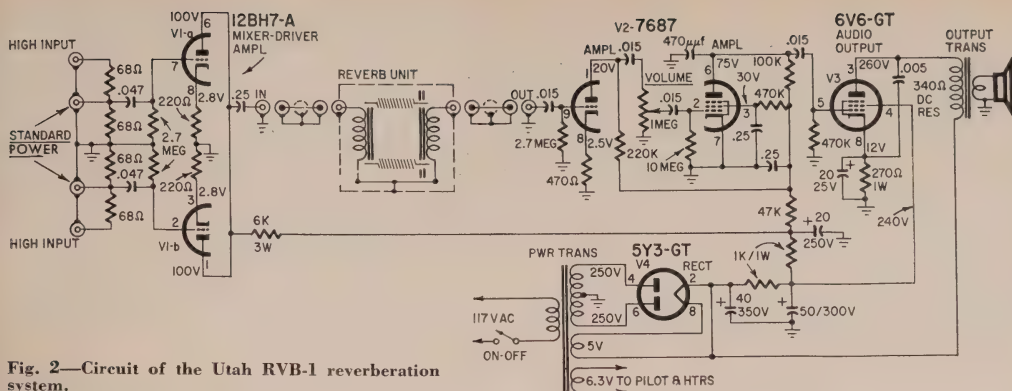


Fig. 2—Circuit of the Utah RVB-1 reverberation system.

delay, in varying amounts, some of the sound reaching the ear. In the units to be described, a coil spring is used as the delay line. A driving transducer, fed with a portion of the audio signal, vibrates the spring at one end. This signal travels down the spring to a pickup and is reflected to the other end of the spring. It then dances back and forth, decaying as it goes, between the ends of the spring, producing delayed complex electrical images of the original sounds in the output of the pickup. The stronger the driving signal, the longer the spring vibrates and the longer the overall delay.

Signals from the pickup are reproduced in a separate amplifier and speaker system or fed back into the existing audio system to be reproduced as reverberation along with the original sounds. Reverberation is most effective at mid-range frequencies so electronic circuits immediately before and after the delay line have response limited to the approximate range of 200 to 4,000 cycles.

Two basic types of delay lines are being used. One is made by Hammond Organ Co. and the other by CBS Electronics. The Hammond reverberation device is used in all reverb units except the CBS. It consists of two coil-spring delay lines designed for delays of approximately 28 and 37 milliseconds. Each delay line consists of two springs wound in opposite directions and joined together at the center (Fig. 1-a). (Winding the springs in opposite directions minimizes the effects of external vibrations and reduces the tend-

ency to unwind over a period of time.)

The ends of the delay lines are fastened to rotors of torsional type electromagnetic transducers (Fig. 1-b). The ferrite cores are magnetized crosswise so they twist in the varying magnetic field developed by the driving coil. The transducer at one end is the driver, and the other is the pickup. The signal fed to the driver coil causes the rotor to twist back and forth like the armature of a D'Arsonval meter (Fig. 1-c). The direction and amplitude of the rotor's motion are in proportion to the direction and amplitude of the signal in the coil.

The twist applied by the driver's rotor travels down the spring to the pickup rotor, which induces a delayed replica of the driver voltage in the pickup coil. This process is repeated a number of times for each initial signal fed to the driver. Thus, when the pickup's output is reproduced, the result is a complex of signals of different time delays and amplitudes that simulates the acoustics of a concert hall.

Speaker type add-on units

Fig. 2 is the schematic of the Utah RVB-1 reverberation system. The Lafayette SK-204 and Radio Shack (catalog No. K31CX543) are similar in circuitry and appearance. The inputs to the reverberation amplifier are connected across the speaker terminals in the existing audio system. The STANDARD POWER inputs are used for stereo amplifiers delivering up to 30 watts per channel. The HIGH INPUT jacks are

for amplifiers with more than 30 watts per channel.

In a monaural system, either the right or left input cable is connected across the voice-coil terminals. The input signal is amplified and fed to the driver transducer of a Hammond reverberation unit. The output of the delay line is passed through a three-stage 7687-6V6-GT amplifier to a built-in speaker.

When the RVB-1 is used with a stereo system, the input terminals are bridged across the right- and left-channel speaker terminals. The signals are mixed in the common plate circuits of the 12BH7-A. From there on, the signal is delayed and reproduced as in a monaural setup. The reverberation speaker acts as a phantom center channel in a stereo installation.

The RVB-1 reverberation amplifier and 8-inch PM speaker are in a 10 x 20 x 10-3/16-inch finished bookshelf type enclosure. Power output is 3 watts. The RVB-1 comes with two 15-foot cables with phono plugs on one end and stripped and tinned at the other.

A transistor unit

The Calbest 603-T Reverb-O-Plex reverberation unit is transistorized as shown in Fig. 3. Signals from the speakers in a stereo system are fed through 100-ohm decoupling resistors and mixed (A + B) in the 2,500-ohm REVERB CONTROL. The signal is then delayed and fed through a three-stage amplifier to the built-in speaker.

Ordinary monaural radios and amplifiers with 3-ohm speakers may not pro-

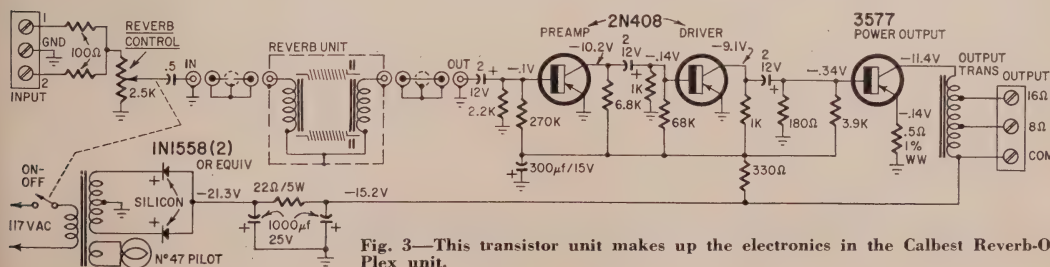


Fig. 3—This transistor unit makes up the electronics in the Calbest Reverb-O-Plex unit.

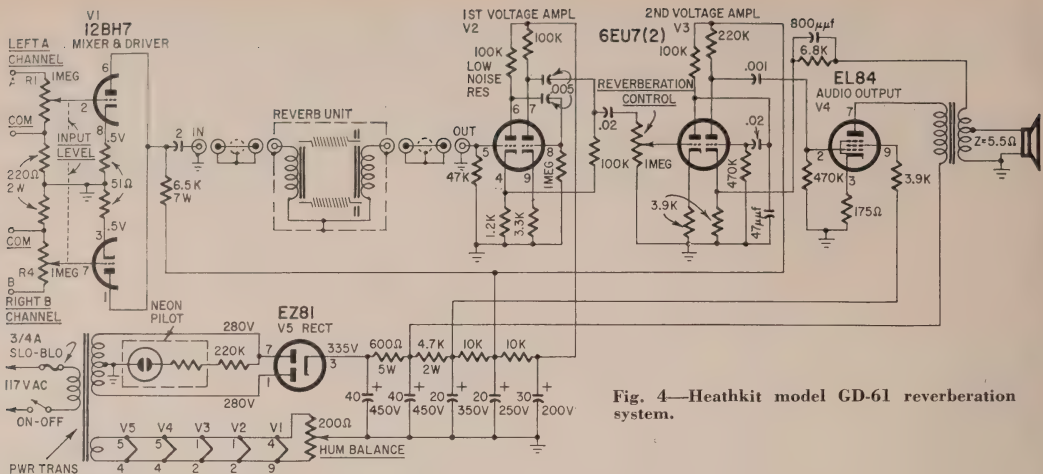


Fig. 4—Heathkit model GD-61 reverberation system.

vide enough drive voltage for these add-on systems, so the right and left input circuits must be paralleled across a 3-ohm speaker system.

Heath GD-61

This reverberation system (Fig. 4) is similar in circuitry and operation to the Utah system. Extra features are two more stages of voltage amplification and an input level control. Its fre-

quency response is 3 db from 200 to 4,000 cycles with less than 2% harmonic distortion at 3 watts output. It requires a 250-mv input for a 3-watt output. Reverberation decay time is approximately 2 seconds at 300 cycles. The GD-61 is supplied completely assembled and wired with amplifier, Hammond delay line and 8-inch mid-range speaker in 11½ x 23 x 11¼-inch bookshelf type enclosure.

In a stereo installation, leads from the left-channel speaker are connected across R1 (between terminals A and COM) and the leads from the right-channel speaker connect across terminals B and COM. The signals to terminals A and B must be in phase for proper operation of the system. For mono, terminals A and B are strapped together and signal leads connected to A and either of the two COM terminals. END



By **FRED SHUNAMAN**
MANAGING EDITOR

NEW THOUGHT IN SERVICE BENCHES

Your Managing Editor inspects the setup on the third bench (foreground). At fourth bench is Peter Mumola, son of proprietor and head of a local short-wave club; behind him Ernest Mumola, and, at the rear, veteran radio repairman Chris De Loura.



THE SERVICE BENCH IS THE TECHNICIAN'S most important piece of equipment. As such, it has become pretty well standardized, and service benches differ very little from one end of the country to the other. Service bench design has apparently come pretty close to perfection.

This opinion is not shared by Ernest Mumola, proprietor of Manhattan Television Co. of New York City. His bench is not, in fact, a bench at all, but a series of nine, individual benches, set end-on to the wall. Each small bench is 2 feet wide and extends 4 feet out from the wall, large enough to accommodate the largest TV chassis.

Each of the small benches has its own outlets, and a convenient number

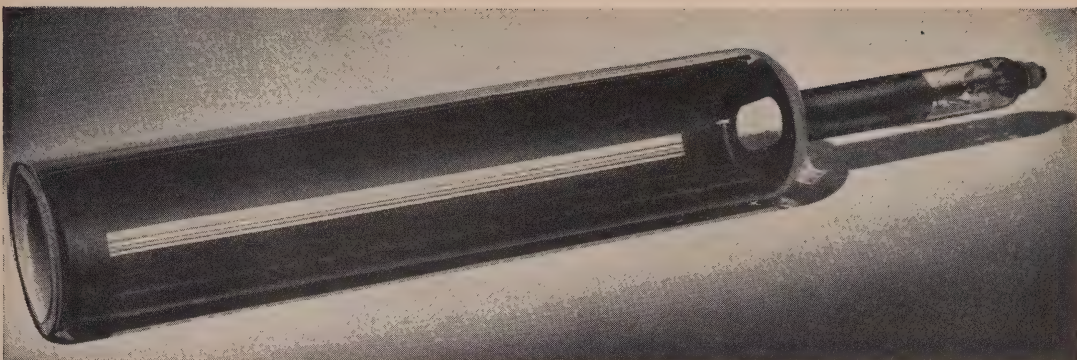
of them are supplied with tools. The larger service instruments are shared by all benches, and are kept on the shelf that runs along the wall.

One advantage of this setup will jump out at every technician. When it is necessary to postpone work on a set for any reason, it can be left right where it is and the technician can work on the next set on another bench. Test equipment can be left clipped into the circuit if it is not needed elsewhere.

Other advantages are not so obvious but none the less real. The technician is not interfered with by the man in the next working position. There is a certain privacy that helps concentration and makes for better work. There is less

danger, if the technician steps back from the bench, of colliding with someone carrying a chassis down the aisle. Since each technician is facing front, a customer is seen entering the store immediately, even though there may be only one man in the shop.

This "bench" appears unique, but may not be the only one of its kind. There may even be other unorthodox and efficient variations in service benches (or other features of shop equipment, technique or management) that might give the alert technician some useful ideas. If you know of any, tell us about them. RADIO-ELECTRONICS will pay good rates for usable articles or short descriptions. END



BANANA TUBE IS COLOR CRT

New picture tube for color TV combines mechanical and optical scanning systems

By ERIC LESLIE

A NEW TYPE OF COLOR TV TUBE HAS BEEN developed by scientists of the British Mullard Co., in cooperation with Dutch Philips. It combines a number of features that have been used in widely different types of television display devices. Although cylindrical instead of flat, it has the gun mounted parallel with the "face" of the tube (if this tube

against a mirror shaped to correct picture distortion caused by the screen and lens system, and to produce a virtual image that appears to be some distance behind the mirror, and therefore larger (Fig. 3). The tube is light-proof except for the cylindrical lenses. Thus the projection is not diluted by other light on the mirror, as would be the case if the beam were projected on a light screen.

1,000 rpm for the standard British 50 fields per second. The drum is governed by a control not unlike the afc in ordinary TV sync systems.

The tube uses quite a bit of power—3 ma at 25 kv. That is the reason for the heat-dissipating films shown in Fig. 3. Brightness of 40 foot-lamberts is claimed.

The research team that developed the tube is careful to point out that it

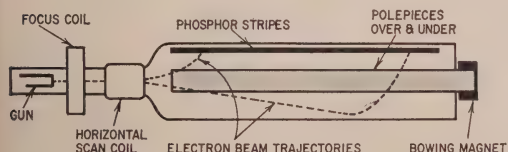


Fig. 1—Basic diagram of the tube. Spot-wobble coils, not shown, direct the beam to the proper phosphor.

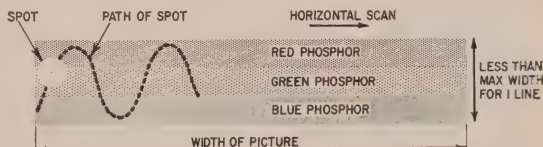


Fig. 2—Color phosphor layout. Total stripe width is about $\frac{1}{4}$ inch wide and 16 inches long.

can be said to have a face) and bends the beam to strike the phosphor at the desired point. It uses the "virtual image" principle introduced in the Philco battery TV (RADIO-ELECTRONICS, August, 1960). It goes far back historically in two important details—it uses *mechanical* scanning in the vertical sweep, and it uses optical lenses, which go back to the de Forest TV sets of the early '30's.

The new tube is called the "banana," partly to follow the tradition of the Philco "apple" and partly because of its shape. The gun is mounted at one end and a special yoke or "bowing magnet" produces the horizontal sweep (Fig. 1). The screen is a narrow strip $\frac{1}{4}$ inch wide and 16 inches long, composed of three color stripes, as shown in Fig. 2. The beam is wobbled up and down, as in the Lawrence tube, for the desired color.

From here, the action is different from that of any previous color tube. The device becomes a special kind of projection tube. Light from the phosphors strikes a rod like cylindrical lens mounted on a drum which runs the length of the tube, and is projected

Three lenses are used. When the first reaches the bottom of the screen, the second starts to scan from the top. The lenses are mounted on a drum that encircles the tube and turns at about

is still a long way from commercialization, and that work will still have to be done on it before it can be determined whether it will be a serious rival of other color TV tubes. END

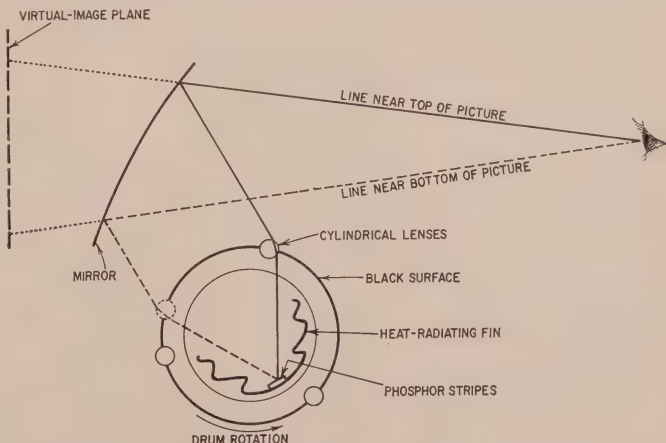


Fig. 3—End view shows rotating drum that surrounds the tube. This drum carries three lenses.

TRANSISTOR ROUNDUP

By JAMES R. SPENCER

HAVE YOU THOUGHT OF ENTERING THE challenging field of transistor circuitry, only to be discouraged by the thousands of types on the market today? Have you scanned the ads and sorted through stacks of manufacturers' spec sheets looking for just the right low-cost transistor for your circuit? Are transistors available that can give you needed watts of audio power? Are high-frequency transistors all high-priced? If these are your problems, "Transistor Roundup" will help you find the right transistor, at the right price.

The directory distills over 2,000 manufacturers' transistor specification sheets into a listing of about 500 readily available low-cost transistors. Availability was the first consideration in compiling the list. All the transistors listed are in stock at most large electronics parts stores or can be ordered from large electronic parts mail-order houses. Price was the second consideration. Bound by these two limitations, each transistor included was selected to provide the widest possible range of types, operating characteristics and case styles. Audio-frequency transistors included range from the microminiature low-noise hearing-aid amplifier 2N207 to the massive 2N1554 power amplifier. For radio-frequency applications, transistors are listed which operate from 455 kc (2N94) to 250 mc (2N588). For industrial control applications, a wide range of switching tran-

sistors has been included.

Type No.—Transistors are listed numerically according to their Electronic Industries Association (EIA) registration number. For some type numbers, A and B types are indicated as also being available. They usually have more closely controlled electrical characteristics and are generally more expensive than the price indicated in the third column. A "+" following the type number indicates the transistor is considered obsolete and not recommended for new equipment design.

Mfr.—The manufacturers are coded numerically according to the following list. Where more than one manufacturer is given for a particular type number, the first one listed is known to offer the specific transistor in the price range indicated in the next column. The remaining manufacturers may or may not offer it at the same price.

Code Number	Manufacturer
1	Bendix Aviation Corp.
2	CBS Electronics
3	Clevite Transistor Products
4	Delco Radio Div., GMC
5	General Electric Co.
6	General Transistor Corp.
7	International Transistor Corp.
8	Motorola Inc.
9	Philco Corp.
10	Radio Corp. of America
11	Raytheon Co.
12	Sprague Electric Co.
13	Sylvania Electric Products, Inc.
14	Tung-Sol Electric Co.
15	Texas Instruments Inc.

Price—Because of regional and other variances, exact price is not quoted; the

type number is indicated in one of three price ranges: *under \$1, **from \$1.01 to \$2.50 and ***from \$2.51 to \$5.

Type—To indicate biasing requirements, the type, n-p-n, or p-n-p, is given. N-p-n transistors require negative bias on the emitter and positive bias on the collector with respect to the base. P-n-p transistors require positive bias on the emitter, negative bias on collector.

Typical Application—This column should be self-explanatory. Typical uses such as af amplifier, oscillator, driver, rf converter, mixer, if amplifier and many others are suggested.

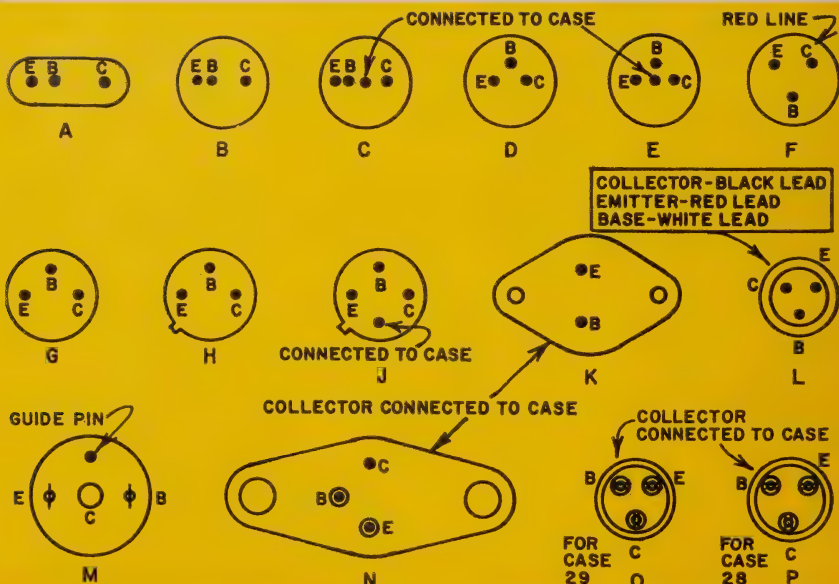
Case—The numbers in this column refer to the transistor case silhouettes which are shown about actual size.

Base—The letters in this column refer to the basing diagrams. Many manufacturers connect one or another of the leads to the case structure, so the individual transistor specification sheet should be referred to before connecting the transistor into a circuit, especially for base diagrams B, G and H.

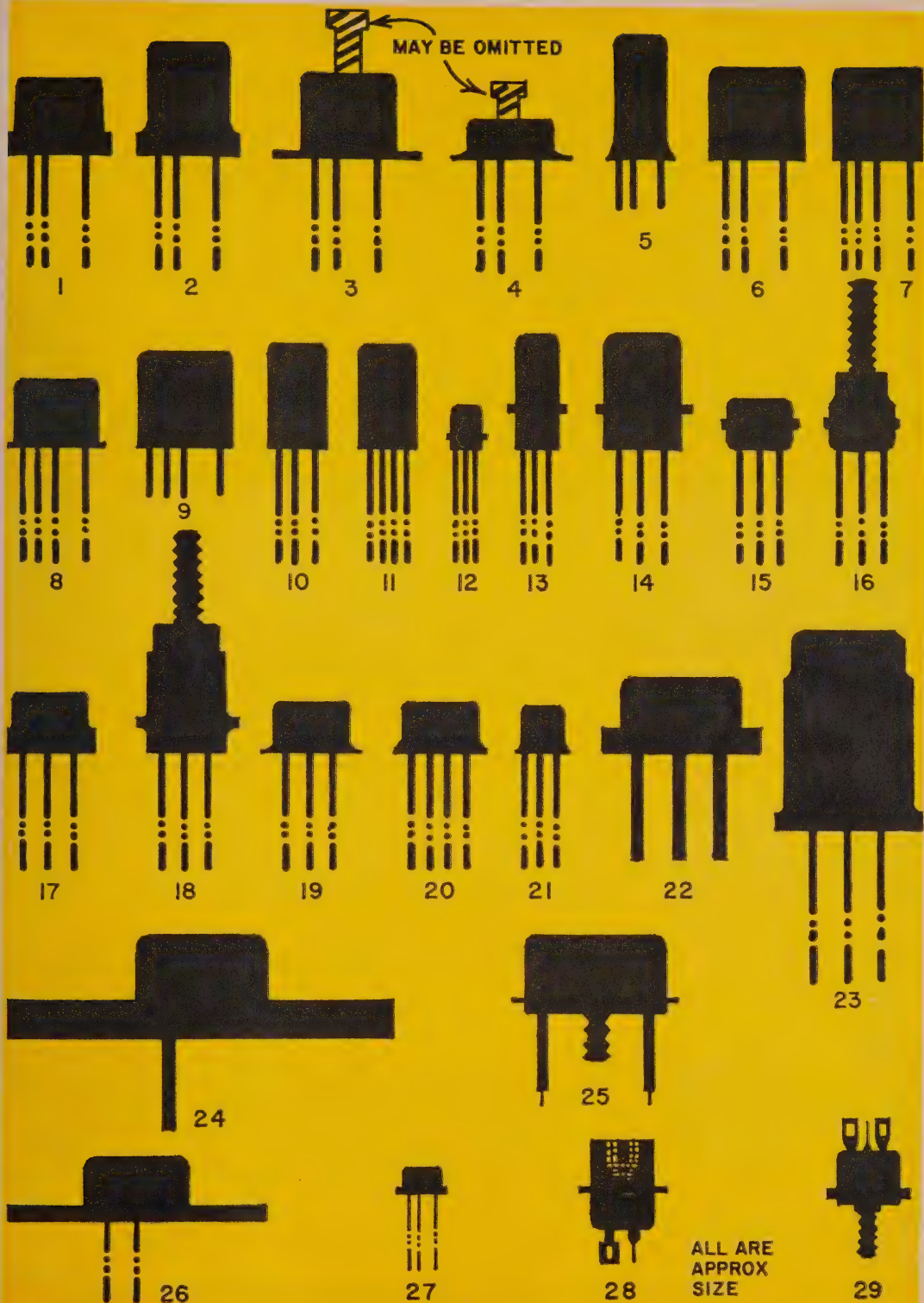
Max Ratings—Three pertinent maximum ratings are given for each transistor: V_{CB} , the maximum collector-to-base dc voltage in volts; I_C , the maximum dc collector current in milliamperes, or amps where noted; and the maximum collector dissipation in milliwatts, or watts where noted. These maximum ratings are absolute values which, if exceeded, will cause permanent damage to the transistor.

h_{fe} or h_{FE} — h_{FE} is the small-signal ac forward-current transfer ratio. h_{FE} is the dc forward-current transfer ratio. In more common terms, they represent ac or dc gain. Typical values are given wherever possible.

Alpha Cutoff Frequency—This is the frequency at which alpha (short-circuit emitter-to-collector current gain) is 0.707 of its low-frequency value.



Outline drawings.



Basing diagrams.

#Beta frequency cutoff.

1

TYPE NO.	MFR.	PRICE	TYPE	TYPICAL APPLICATION	CASE BASE	MAX RATINGS			Collector Disposition	Wiring	Avia China Frequency
						V _{CE}	I _C	P _D			
1N1540	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	5 A	30 W	75		4 kc
1N1541	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	3 A	30 W	75		4 kc
1N1542	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	3 A	30 W	125		4 kc
1N1543	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	5 W	30 W	125		4 kc
1N1546	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	15 A	30 W	20		10 kc
1N1549	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	15 A	30 W	20		10 kc
1N1551	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	15 A	30 W	40		5 kc
1N1552	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	15 A	30 W	40		5 kc
1N1553	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	15 A	30 W	40		5 kc
1N1554	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	15 A	30 W	75		4 mc
1N1555	8	***	p-n-p	at power amp./hiq-car switch	24 K	-60	15 A	30 W	75		4 mc
1N1605	13	***	n-p-n	medium-freq switch	19 H	35	100	150	40		4 mc
1N1611	4	***	p-n-p	at (high-power amp)	26 N	-60	1.5 A		50		45 mc
1N1612	10	***	p-n-p	at (high-freq amp)	5 B	-34	10	80	80		45 mc
1N1631	10	***	p-n-p	at (455 kc amp)	10 D	-34	10	80	80		45 mc
1N1632	10	***	p-n-p	at (455 kc amp)	5 B	-34	10	80	75		40 mc
1N1633	10	***	p-n-p	at (455 kc amp)	10 D	-34	10	80	75		40 mc
1N1636	10	***	p-n-p	at (high-freq converter)	5 B	-34	10	80	75		45 mc
1N1638	10	***	p-n-p	at (high-freq converter)	10 D	-34	10	80	75		45 mc
1N1637	10	***	p-n-p	at (455 kc amp)	10 D	-34	10	80	75		45 mc
1N1639	10	***	p-n-p	at (high-freq converter)	10 D	-34	10	80	75		40 mc
1N1681	14	***	p-n-p	at (high-freq switch)	19 H	-34	10	80	75		40 mc
1N1705	14	***	p-n-p	at (driver)	19 H	-18	400	200	110		4 mc
1N1706	14	***	p-n-p	at (driver)	19 H	-25	400	200	90		3 mc
1N1707	14	***	p-n-p	at (driver)	19 H	-30	400	200	100		3 mc
1N1726	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1727	8	***	p-n-p	at (converter/mixer/osc)	15 G	-20	50	60	60		150 mc
1N1728	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1742	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1743	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1744	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1745	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1746	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1747	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1748	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1749	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1750	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1751	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1752	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1785	8	***	p-n-p	at (driver)	15 G	-12	50	60	250		106 mc
1N1786	8	***	p-n-p	at (driver)	15 G	-10	50	45	60		125 mc
1N1787	8	***	p-n-p	at (driver)	15 G	-15	50	45	60		125 mc
1N1788	8	***	p-n-p	at (driver)	15 G	-15	50	45	60		125 mc
1N1789	8	***	p-n-p	at (driver)	15 G	-35	50	60	60		150 mc
1N1790	8	***	p-n-p	at (driver)	15 G	-35	50	60	60		150 mc
1N1791	8	***	p-n-p	at (driver)	15 G	-35	50	60	60		150 mc
1N1808	15	***	p-n-p	at (driver)	19 H	25	300	150	40		4 mc
1N1864	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		125 mc
1N1865	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		125 mc
1N1866	8	***	p-n-p	at (driver)	15 G	-35	50	60	60		150 mc
1N1867	8	***	p-n-p	at (driver)	15 G	-35	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1869	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
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1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
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1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		150 mc
1N1868	8	***	p-n-p	at (driver)	15 G	-20	50	60	60		

 $f_{\text{gain}} = \text{gain bandwidth product}$

TYPE NO.	MFR.	PRICE TYPE	APPLICATION	CASE	BASE	MAX RATINGS			No. Pins	Alpha Frequency
						V _{CE} V	I _C mA	Collector Diss. W		
2N1324	2	***	p-n-p	28	O	80	3 A	23 W	90	10 kc
2N1326	2	***	at (driver)/switch	28	P	100	3 A	23 W	90	
2N1328	2	***	at (driver)/switch	28	P	35	3 A	23 W	90	
2N1330	2	***	at (driver)/switch	28	P	80	3 A	23 W	90	
2N1333	2	***	at (driver)/switch	28	P	100	3 A	23 W	90	
2N1335	2	***	at (driver)/switch	24	K	50	3 A	90 W	55	
2N1359	8	***	at (power amp)	24	K	50	3 A	90 W	55	
2N1360	8	***	at (power amp)	24	K	50	3 A	90 W	55	
2N1362	8	***	at (power amp)	24	K	100	3 A	90 W	55	
2N1370	15	***	at (amp/osc./driver)	19	G	45	150	150	100	
2N1371	15, 13	**	at (amp/osc./driver)	19	G	45	150	150	100	
2N1372	13, 15	**	at (amp/osc./driver)/switch	19	H	25	200	150	60	
2N1373	13, 15	**	at (amp/osc./driver)/switch	19	H	45	200	150	60	
2N1374	13, 15	**	at (amp/osc./driver)/switch	19	H	45	200	150	60	
2N1375	13, 15	**	at (amp/osc./driver)/switch	19	H	45	200	150	60	
2N1376	13, 15	**	at (amp/osc./driver)/switch	19	H	25	200	150	120	
2N1377	15	**	at (amp/osc./driver)/switch	19	G	45	200	250	120	
2N1378	15	**	at (amp/osc./driver)/switch	19	G	12	200	250	200	
2N1379	15	**	at (amp/osc./driver)/switch	19	G	12	200	250	200	
2N1380	13, 15	*	at (amp/osc./driver)/switch	19	H	12	200	150	200	
2N1381	13, 15	*	at (amp/osc./driver)/switch	19	H	25	50	150	200	
2N1382	15	**	at (amp/osc./driver)/switch	19	G	25	200	200	100	
2N1383	15	**	at (driver/push-pull output)	19	G	25	200	200	100	
2N1395	10	***	at (driver/push-pull output)	20	J	40	10	120	90	
2N1396	10	***	at (1.5-12.5 mc amp)	20	J	40	10	120	90	
2N1397	10	***	rf (30-mc amp)	20	J	40	10	120	90	
2N1400	15	***	power signal amp	20	O	30	10	50	50	
2N1401	15	***	rf (vib. amp/osc)	20	O	30	10	50	50	
2N1402	15	***	high-speed switch	20	J	35	35	2	50	
2N1404	15	***	high-speed switch	20	J	35	35	2	50	
2N1411	9	***	med-freq switch	13	G	15	50	25	125	
2N1416	2	***	at (amp/osc./driver)	14	F	18	150	250	110	
2N1425	10	*	at (455-kc amp)	7	C	24	10	80	24	
2N1426	10	*	rf (500-1640-kc converter)	7	C	24	10	80	24	
2N1431	13	***	at (amp/osc./driver)	2	A	25	100	180	125	
2N1433	2	***	at (power amp)/switch	28	P	80	3.5 A	30 W	50	
2N1434	2	***	at (power amp)/switch	28	P	80	3.5 A	30 W	50	
2N1435	2	***	at (power amp)/switch	28	P	80	3.5 A	30 W	50	
2N1436	2	***	at (power amp)/switch	28	P	100	3 A	23 W	40	
2N1438	2	***	at (power amp)/switch	28	P	100	3 A	23 W	40	
2N1453	2	***	at (power amp)/switch	28	P	30	5 A	43 W	50	
2N1454	2	***	at (power amp)/switch	28	P	30	5 A	43 W	50	
2N1455	2	***	at (power amp)/switch	28	P	60	5 A	43 W	50	
2N1456	2	***	at (power amp)/switch	28	P	60	5 A	43 W	50	
2N1457	2	***	at (power amp)/switch	28	P	80	5 A	43 W	50	
2N1458	2	***	at (power amp)/switch	28	P	80	5 A	43 W	50	
2N1461	2	***	at (power amp)/switch	29	O	30	5 A	43 W	50	
2N1462	2	***	at (power amp)/switch	29	O	60	5 A	43 W	50	
2N1463	2	***	at (power amp)/switch	28	P	60	5 A	43 W	50	
2N1465	2	***	at (power amp)/switch	28	P	120	3 A	20 W	40	
2N1466	2	***	at (power amp)/switch	29	O	120	3 A	20 W	40	
2N1478	9	***	high-speed switch	15	G	30	100	250	70	
2N1489-1	9	***	high-speed switch	15	G	30	100	250	70	
2N1504	2	***	at (power amp)/switch	16	L	60	3 A	23 W	60	
2N1524	10	*	at (455-kc amp)	10	D	24	10	80	60	
2N1525	10	*	at (455-kc amp)	5	B	24	10	80	60	
2N1526	10	*	rf (500-1640-kc converter)	10	D	24	10	80	60	
2N1527	8	***	at (power amp)/high-curr switch	24	K	80	5 A	90 W	30	
2N1528	8	***	at (power amp)/high-curr switch	24	K	80	5 A	90 W	30	
2N1529	8	***	at (power amp)/high-curr switch	24	K	80	5 A	90 W	30	
2N1530	8	***	at (power amp)/high-curr switch	24	K	80	5 A	90 W	30	
2N1532	8	***	at (power amp)/high-curr switch	24	K	80	5 A	90 W	30	
2N1533	8	***	at (power amp)/high-curr switch	24	K	80	5 A	90 W	30	
2N1534	8.4	***	at (power amp)/high-curr switch	24	K	60	5 A	90 W	55	
2N1535	8.4	***	at (power amp)/high-curr switch	24	K	60	5 A	90 W	55	
2N1536	8	***	at (power amp)/high-curr switch	24	K	80	5 A	90 W	55	
2N1538	8	***	at (power amp)/high-curr switch	24	K	80	5 A	90 W	55	

ANTI-CHATTER CAPACITORS

To keep plate relays quiet . . . use a capacitor, a resistor or a combination of both

THE word "chatter" has many meanings to many people. But to an industrial electronic technician, it means only one thing: "Some relay is buzzing like crazy; it seems to be pulled in, but the load is not receiving normal power."

How do we cure the situation? Hook a capacitor across the relay coil! Like the solutions to a lot of other problems, this one sounds suspiciously simple, and it is.

First, let's figure out *why* the relay chatters. Fig. 1 shows the circuit of a simple on-off type of electronic timer that might be used for life-testing relays, solenoid valves, etc. Relays in this circuit are used in the same way as in many common industrial circuits. RY1 and RY2 are connected in the anode (plate) circuits of thyatron tubes. Each relay has a capacitor-resistor circuit across its coil.

The timing circuit is a little unusual because of the placement of the timing capacitors, and exactly how they charge may not be apparent. On negative half cycles the grid end of these capacitors is charged negatively through grid-cathode conduction in the thyatron from the upper side of the line (Fig. 1, from point A via the ac relay coil to cathode and thence to grid). The current drawn to charge these capacitors is very small and does not energize RY3.

RY1 and RY2 require protection

against chatter because they are being energized by the plate current of electron tubes.

The plate supply for thyatrons V1 and V2 is raw ac from the line. This is common practice in industrial gas-tube circuits. Although we might not think of it right off, C1 and V2 are actually rectifiers, since they can pass current only when their plates are positive with respect to their cathodes. That means that RY1 and RY2 have current flowing through them only when line A is positive, unless we arrange some other supply (Fig. 2).

Filter the ripple

Since we apply pulsating dc to the relay coils, though we would prefer smooth dc, why not filter the ripple, as we do in a radio or TV power supply? That is just what has been done here. An electrolytic capacitor is connected across each relay coil to store energy

when the tube conducts, and release it to keep the relay pulled in when the line polarity keeps the tube from conducting.

But why the 100-ohm resistor in series with the capacitor? It serves the same purpose as the surge resistor in a radio or television power supply.

At the time the thyatron begins to fire (conduct), the capacitor across the relay coil is completely discharged. Like any other capacitor in this condition, it represents almost zero impedance between the thyatron plate and line A. If we leave the thyatron connected across the line for even an instant with no impedance in series to limit current flow, the tube will certainly be damaged. The 100-ohm resistor limits plate current until the capacitor begins to charge. (The resistance used here is not critical, and 100 ohms is a common value.)

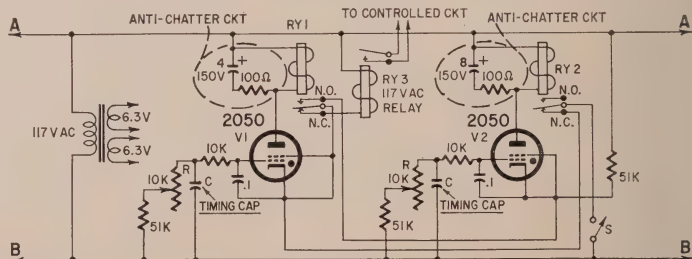


Fig. 1—Simple on-off timer circuit using thyatrons. Anti-chatter circuits are enclosed in dashed lines.

*Director, industrial electronics, Radio Electronic Television Schools, Detroit 26, Mich.

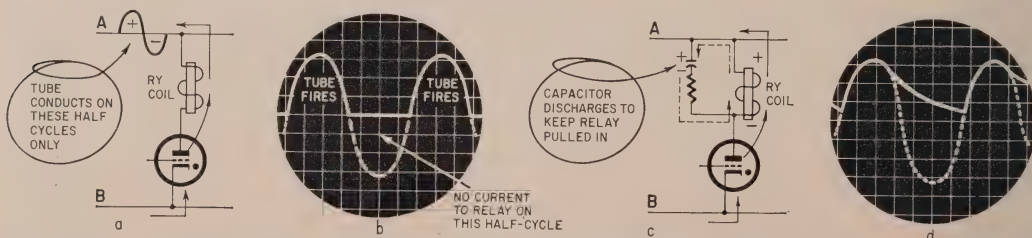


Fig. 2—a—With no anti-chatter network, current flows through coil only when A is positive, because of tube's rectifying action. b—Waveform across relay coil with no chatter protection.

c—Anti-chatter capacitor keeps current flowing during "off" half-cycles. d—Waveform across relay with anti-chatter network.

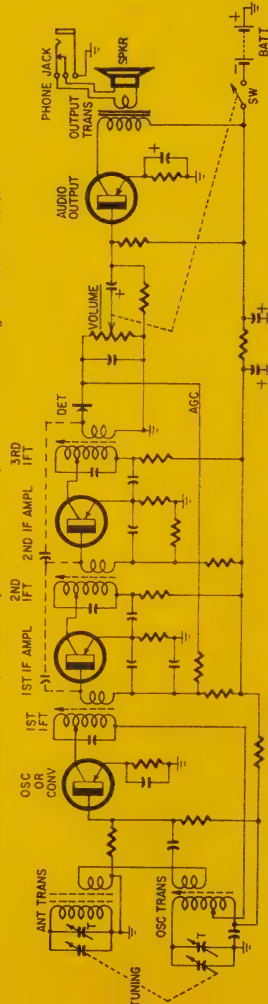
Radio Troubleshooting

Chart II

By LEONARD D'AIRO

Last month we printed a systematic troubleshooting chart for radios. This month we look at a transistor radio. Again the chart demonstrates a methodical approach to troubleshooting and cannot be followed too literally, as procedures will necessarily vary somewhat from set to set. However, as a basic guide, you will find it hard to beat.

The chart this month is prepared by Leonard D'Airo, author of *Servicing Transistor Radios*.



RADIO DEAD—NO NOISE FROM SPEAKER

Check Battery Voltage at Terminals.

VOLTAGE OK

DEFECTIVE SWITCH

Clean switch contacts.
Replace switch.

SWITCH OK

- Leaky or shorted supply filter capacitor.
- Shorted bypass capacitor.
- Poor phone jack contact.
- Defective transistor.
- Defective speaker or output transformer.

NO VOLTAGE

Replace battery.
Check battery terminals for corrosion.

RADIO DEAD—HISS FROM SPEAKER

Check voltage at collectors of audio transistors.

VOLTAGE OK

Put finger on base terminal of audio output transistor. A hum should be heard in the speaker.

VOLTAGE LOW

Replace battery.

SOUND HEARD

With a metal probe (such as a screwdriver) touch base terminals of second and first if transistors. Sounds should be heard.

NO SOUND

Defective transistor.

SOUND HEARD

Touch base terminal of oscillator or converter transistor.

NO SOUND

- Open base winding 2nd or 3rd if transformer.
- Open collector winding 2nd or 3rd if transformer.
- Shorted bypass capacitor.
- Defective transistor.

SAME SOUNDS

- Shorted bypass capacitor.
- Shorted coupling capacitor.
- Defective oscillator transistor.
- Open or shorted oscillator coil.
- Open or shorted antenna coil.

NO SOUND

- Defective oscillator transistor.
- Open or shorted oscillator coil.
- Shorted bypass capacitor.
- Open 1st if collector winding.

SET OPERATES ABNORMALLY

Weak Signals, Noise, Distortion, Etc.

OSCILLATOR (CONVERTER)

WEAK SIGNAL, LOW END
a) Defective transistor.
b) Misadjusted oscillator coil.

WEAK SIGNAL, HIGH END
a) Defective transistor.
b) Broken or cracked antenna coil core.
c) Misaligned antenna coil.

HIGH FREQUENCY CUT OUT
a) Open emitter bypass capacitor.
b) Defective transistor.
c) Misalignment.

IF AMPLIFIERS

POOR SENSITIVITY
a) Defective transistor(s).
b) Open bypass capacitor.
c) Misalignment.
d) Excessive age voltage.

WHISTLES
a) Misalignment.
b) Defective neutralizing components.

DISTORTION
a) Low or no age voltage.
b) Low battery voltage.
c) Defective transistor(s).

NOISE
a) Defective transistor(s).
b) Corroded solder connections in IF transformer.

MOTORBOATING
a) Misalignment.
b) Open decoupling capacitor.
c) Weak battery.

SQUEALS
a) Misalignment.
b) Open decoupling capacitor.

DETECTOR (DIODE OR TRANSISTOR)

WEAK SIGNAL
a) Defective rf bypass capacitor.
b) Misalignment.
c) Defective diode or transistor.

NO AGC VOLTAGE
a) Defective diode.
b) Defective transistor.
c) Shorted rf bypass capacitor.
d) Shorted age filter capacitor.

DISTORTION
a) Shorted a) coupling capacitor.
b) Shorted age filter capacitor.
c) Defective diode or transistor.

AUDIO DRIVER

LOW AUDIO OUTPUT
a) Open emitter bypass capacitor.
b) Defective transistor.

MOTORBOATING
a) Open decoupling capacitor.
b) Open supply filter capacitor.

DISTORTION
a) Shorted emitter bypass capacitor.
b) Defective transistor.

AUDIO OUTPUT STAGE (CLASS A OR B)

LOW OUTPUT
a) Open emitter bypass capacitor.
b) Defective speaker.
c) Defective transistor.

MOTORBOATING
a) Open supply filter capacitor.
b) Open decoupling capacitor.
c) Change in value of feedback resistor.

DISTORTION

c) Shorted primary turns in output transformer.
d) Defective transistor.

a) Defective speaker.
b) Shorted emitter bypass capacitor.

REFLEX IF AMPLIFIER

WEAK SIGNAL
a) Open base bypass capacitor.
b) Open emitter bypass capacitor.
c) Open rf choke.
d) Defective coupling capacitor.
e) Defective transistor.

DISTORTION
a) Shorted a) coupling capacitor.
b) Shorted emitter bypass capacitor.

GENERAL

NOISE
a) Dirty volume control.
b) Dirty tuning capacitor.
c) Leaky electrolytic capacitor.

SHORT BATTERY LIFE
a) Defective switch.
b) Shorted or leaky supply filter capacitor.
c) Defective transistor.

DRIFT

a) Weak battery.
b) Defective oscillator transistor.

FADES

a) Weak battery.
b) Defective transistor.

INTERMITTENT

a) Dirty switch contacts.
b) Corroded battery terminal.
c) Poor solder connections.
d) Dirty tuning capacitor.

BUILD

ELECTRONIC SHOOTING GALLERY

Practice shooting at home—with a light beam

By R. E. PITTE, JR.

MANY TYPES OF SHOOTING GALLERIES use a light beam, photocell and relay. Most require a target connected to a 117-volt ac outlet. This restricts target placement and presents a possible shock hazard. This shooting gallery avoids these two disadvantages by featuring a transistorized portable, battery-operated target mechanism.

The gun is an inexpensive plastic

fits into a hole on the target. As you have probably guessed, this is the bull's-eye and a 2 3/4-inch focal-length lens is mounted here.

Construction details

Obtain a small plastic pistol and assemble the optical system. Use some fast-drying cement to mount a 3/8-inch-diameter 2-inch focal-length lens on the end of a 3/4 x 3 1/2-inch aluminum or

Now paint the assembly and the water pistol's interior with a flat black paint. When dry, mount it in the gun. With the lamp lit, mount some plastic sights on the top of the barrel and line them up with the beam of light focused on a surface some 10 feet distant. If this is done accurately, target shooting will be very realistic and become a game that requires real skill.

The next step is to couple a single-pole double-throw switching arrangement to the trigger (Fig. 2). A good way to build this is with three small strips of brass. Solder the leads to the brass strips and then glue the strips to the inside of the plastic pistol so the pistol trigger will move the center strip from contact with one strip to contact with the other. When this is set up, reassemble the gun and connect the leads from the switch through a cable to the battery-capacitor arrangement as in Fig. 2.

The target also has an optical system, mounted in a cardboard tube. To determine the proper distance between the lens and the B-2M photocell, hold the lens and focus the light from a

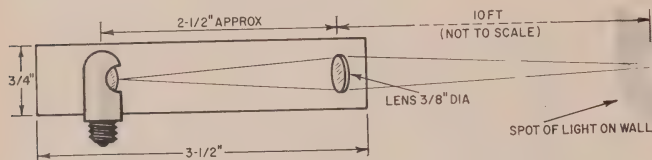


Fig. 1—Optical assembly for the pistol.

water pistol modified to hold the switch mechanism coupled to its trigger, the light bulb and a simple optical system. Its power supply is external. The gun fires a bullet of light of short duration, so the shooter can't move the light beam onto the bull's-eye after pulling the trigger. Hits are registered by a flash of light from a small indicator lamp mounted on the target or a bell or buzzer.

The target is compact. Its working components are mounted on a 2 1/4 x 2 1/4-inch piece of perforated phenolic board. Just below the board is a 3/8-inch diameter black cardboard tube 2 3/4 inches long. A B-2M photocell is fastened to the back of the tube. The other end

plastic strip. Then place a lighted lamp on the other end of the strip. Point the assembly toward a wall about 10 feet away and move the lamp back and forth until it focuses sharply on the wall. Fasten the lamp holder in place at this point (Fig. 1).

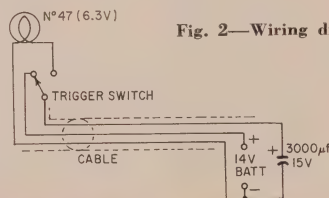


Fig. 2—Wiring diagram for the pistol.

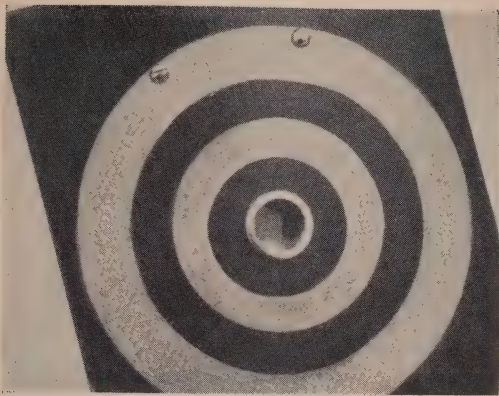
Lamp, 6.3 volts, No. 47
Battery, 14 volts (two 5-volt mercury batteries, and one 4-volt battery in series)
Switch, see text for instructions
Capacitor, 3000 µf, 15 volts
Aluminum or plastic strip, 3/4 x 3 1/2 x 1/16 inch
Plastic pistol
Lens (Edmund Scientific Co., Barrington, N. J., beginners lens kit No. 2)



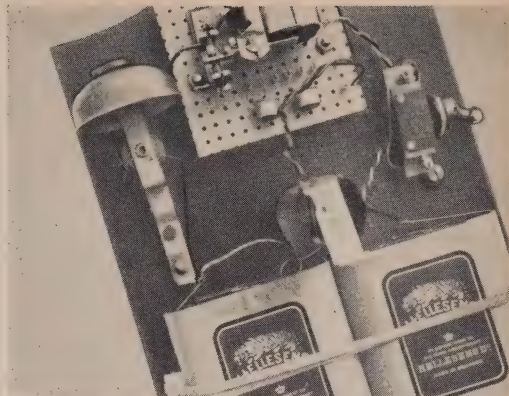
The electrical assembly mounted in the pistol.



Pistol power supply is external. It is made up of 3 mercury batteries and a high-value electrolytic capacitor.



Close-up of the target. Lens is mounted in the bullseye.



Electronic portion of the target. This one uses a bell to indicate hits.

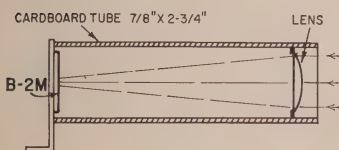


Fig. 3—Simple optical assembly used at the target.

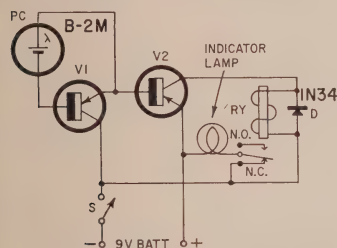


Fig. 4—Target circuit uses two transistors.

Photocell, B-2M (International Rectifier)
Transistors, p-n-p (almost any type)
Relay, Sigma 4F
Diode, IN34
Switch, spst toggle
Battery, 9 volts
Lens (Edmund Scientific Co., Barrington, N. J., beginners lens kit No. 2) (One kit will supply all lenses for this project.)
Cardboard tube, 7/8-inch diameter, 2 3/4 inches long

bright window or ceiling lamp on a piece of white paper. At the proper focus point, you will see an image of the window or lamp on the paper. Measure the distance between the lens and paper at this point. This distance is used when setting up the target optical system (Fig. 3).

The direct-coupled transistor amplifier requires no resistors or capacitors. The diode is inserted only to prevent the collapsing field built up by the relay winding from injuring the transistors. I used some 29-cent p-n-p bargain-base transistor and almost any p-n-p units will work (Fig. 4).

Unlike most photoelectric circuits, this one draws current when idle and cuts off when light strikes the photocell. But since current drain is only 2 ma, the batteries last quite a while.

Set the target relay to pull in at about 1.4 ma and release at 0.8 ma. Some trial adjustments will be necessary before the target responds properly. However, once it is set, you should have no further trouble.

Final comments

Once the unit is set up, there is little that can go wrong. It will work at distances up to 15 feet, although the pistol must be kept steady.

The battery which powers the tran-

sistor amplifier also powers the target-hit indicator. To prolong battery life, it is best to use separate batteries to power the indicator—a small one for the transistor circuit and a large one for the indicator.

Although the battery voltage for the lamp in the pistol is twice the lamp rating, don't worry. The capacitor discharges rapidly and peak voltage is maintained for only a very brief instant each time the trigger is pulled.

Good shooting!

END

Snow in the IF?

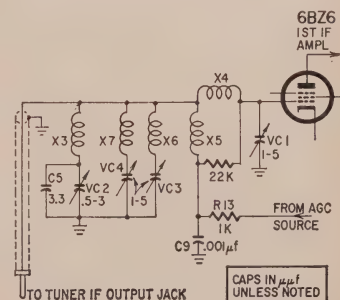
YES, IT CAN HAPPEN HERE. WE USUALLY think of snow as a tuner trouble, but an if can be the culprit. I learned this dramatically from a Philco chassis 11N51. The picture was fair, but the customer complained of snow. He said it had been that way since it was new.

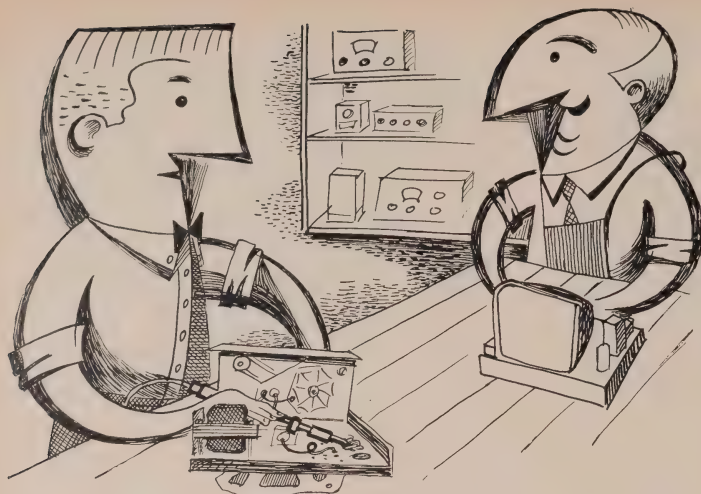
We checked the tuner agc. It was about 4 volts negative. We tried bypassing the antenna transformer with a small capacitor. The age did not increase. We grounded the age to the tuner. The picture overloaded and began to bend—but it was still snowy! This was our first clue that we must have overloading in the if's. Next we tried a quick check with a vtvm at the if agc terminal. The if agc was zero!

We measured the age line with an ohmmeter. There was a 3,000-ohm short going back toward the first if stage. A look at the schematic showed that the age voltage was fed only to the first if stage directly. The resistance to ground on the C9 side of R13 was about 2,000 ohms. Capacitor C9, VC3, VC4, VC2, VC1 or C5 could be leaky. We opened the circuit between X7 and X6. The short was in the tuner direction, but none of the remaining capacitors were leaky!

What was the trouble? Evidently when the set was manufactured, the cable from the tuner had been heated fairly hot and a carbon (or chemical) trail had been deposited across its terminals, leaving an approximate 2,000-ohm leakage. It killed the age and greatly reduced the tuner output. Turned out that all we had to do was reheat the terminals! The leakage disappeared, and needless to say, so did the snow!

Snow had been caused by the if stage running wide open with a reduced signal input!—Mike Wayne





THE OLD-TIMER

Helps Replace a Power Transformer

By **JACK DARR**
SERVICE EDITOR

PART II:—The Young Ham finishes up the power transformer installation with an assist or two from the Old Timer

GUESS it's time to get back to that transformer," said the Young Ham. "OK, I was goin' to get to that subject anyhow," replied the Old-Timer. "Now, let's git that mess off of there and see where we are." The Young Ham picked up a soldering iron and started to disconnect the old wiring.

After unsoldering, he took out the bolts and pried the old transformer loose from the chassis. "Here," said the Old-Timer. "Scrape off as much of that old burnt wax and potting compound as you can, then kinda wash the chassis off with this solvent. This is the stuff cleaners use and it'll cut that gunk. If you don't the thing'll stink so bad when it warms up you'll think it's burning out again."

The Young Ham scrubbed industriously at the chassis. When he had it clean enough for the Old-Timer's satisfaction, he took the new transformer out of its box. His face fell. "Aww, shucks," he said. "It's the wrong kind!"

The Old-Timer ambled over and looked at it. "Be not dismayed," he said. "This is easily fixed. It'll mount there easy as pie. Look ye, youngling, there's only two kinds of transformer

housings. There's the 'upright' like this one, and there's th' 'half-shell' like this one (Fig. 1). There's variations of both of 'em, of course. Sometimes you'll find half-shells without th' bottom shell that this 'n's got, and you'll see uprights without any outside shells at all, and so on. But, you can always mount any of 'em, if you've got room on the chassis.

"I run into that kind of problem this morning. Old transformer was a little squarish potted deal, but I had a little half-shell that was just right. So I took the bolts out of it an' put in long ones an' bolted 'er down snug as a bug in a rug (Fig. 2). It fit all right, and I had plenty of clearance. You can do the same thing here, if you want to."

"OK," mumbled the Young Ham, as he set to work. The Old-Timer wandered back up to his own end of the bench and began working on a TV set. Presently the Young Ham finished the mounting, and exclaimed, "Oh, oh. Where's the box? Now, I don't know where all these wires go."

Where do we go from here

The Old-Timer came over to him.

"Don't need to," he observed. "They're color-coded. Ain't you got a copy of th' code around here somewhere? Yeah, sure. There it is," and he pointed to a large chart of miscellaneous codes and tables tacked to the door (Fig. 3). "Standard color code for power transformers. Now, remember one thing: while you'll find practically all standard replacement transformers coded this way, don't depend on finding the original transformer coded to match! Sometimes the manufacturer made up his own color code as he went along, seems like. You just trace the connections out. That's easy to do: 5Y3 filament, pins 2 and 8; plates pins 4 and 6. Six-volt heater line, usually on pin 2 of the nearest 6-volt tube (one of th' 6V6's, in this case), t'other one to ground. High-voltage center tap to ground. Primary to th' switch and th' line cord, and so on. Find th' wires on this transformer according to th' color code, and awa-a-ay you go."

The Young Ham went busily to work, humming to himself. The Old-Timer grinned, and went back to his TV set. Presently, the Young Ham looked up and announced, "Well, there she is."

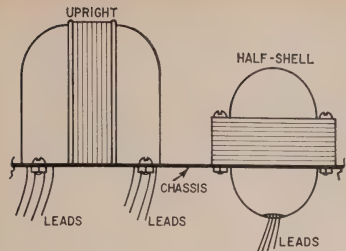


Fig. 1—Upright and half-shell power transformer mounting. Either type can be used to replace the other, if electrical characteristics are the same and there is enough room on the chassis.

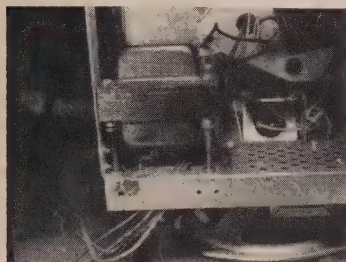


Fig. 2—How to mount a double half-shell transformer to replace an upright or a potted unit.

Want to take a look at it before I start the countdown?"

"Indood I dee," answered the Old-Timer, coming over to him. He inspected the chassis closely, checked the solder joints, and presently agreed that it was all right. The Young Ham beamed. The Old-Timer took a second look at the chassis, grinned to himself, and said, "Well, I'm ready if you are. Now let's run a few careful tests. Remember, we don't know what took the old transformer out yet! So let's pro-ceed with extreme caution, as the feller says. All tubes still out? Good. Now, plug it in th' wattmeter and turn it on." The Young Ham did. The wattmeter needle swung just above zero, then returned to the pin. "Good!" said the Old-Timer. "That's what we oughta have. Y'see, a good transformer has practically no

Primary	Black
High-voltage secondary	Red
High-voltage secondary, ct	Red-yellow
5-volt filament	Yellow
5-volt filament, ct	Yellow-blue
1st 6.3-volt filament	Green
1st 6.3-volt filament, ct	Green-yellow
2nd 6.3-volt filament	Brown
2nd 6.3-volt filament, ct	Brown-yellow
3rd 6.3-volt filament	Slate
3rd 6.3-volt filament, ct	Slate-yellow

Fig. 3—Power transformer color-coding.

and announced, "Well, there she is. losses to speak of, runnin' 'no-load' like that, so you shouldn't see any current drain at all without the tubes. Now, pull it out." The Young Ham complied. "Now, even if you've already done it, measure from the rectifier cathode to chassis with a high range on the ohmmeter. Or, better still, with a 300-volt range on the capacitor checker, to see if we got any B-plus shorts." The Young Ham did, with no results.

"Good again. Now put th' tubes back in and we'll see wha' happens." The Young Ham did so.

"Hey, I don't see the rectifier!" he said. The Old-Timer handed him a new 5Y3 from the shelf-saying, "It's probably no good anyhow. Go ahead and use this one."

The speaker was silent

The Young Ham turned the amplifier on, after connecting the bench speaker to it. The wattmeter needle swung up to a reading of about 30 watts, but the speaker remained silent. The Young Ham looked puzzled. He picked up a voltmeter probe and measured the B-plus. "Hey! I got about 400 volts here!" he cried. "I thought that transformer only had about 300! No sound, either. Now, what's the matter with the darn thing?"

The Old-Timer grinned. "Well, whatever it is, it don't seem to be a short," he observed calmly. "You're only drawin' 30 watts. Look around, an' see if you can't find somethin' missin' that ought to be there."

The Young Ham measured all the plate voltages, and shook his head. "I don't get it at all," he said in bewilderment. "Looky! I've got 400 volts on all the plates, everywhere! What th' heck's goin' on here!"

The Old-Timer burst out laughing. "I'm sorry, Junior," he said. "I just couldn't help it. I saw what you'd done, but I've done it so many times myself that I jist couldn't resist lettin' you hunt for it a while. Try checkin' your filament voltage!"

The Young Ham did. "Hey! No filament! No wonder the thing had such high voltage! None of the tubes were drawing any current!"

"That's right," agreed the Old-Timer. "Now I'll show you why. You connected up the green wires, just like you should, didn't you? What did you do with the green-and-yellow wire, the center tap?"

"Cut it off and taped the end," said the Young Ham. "Why?"

"That's your trouble." The Old-Timer grinned. "Take that tape off an' take a look at them wires." The Young Ham did so.

"See what I mean? Those wires are double. The filament winding is heavy wire. When they made the center tap, they jist brought out the ends of the wires, twisted a loop in 'em, cut and tinned the ends, and stuck that piece of heavy spaghetti over 'em. When you cut 'em off, you cut past the place where they were tinned. What you got there now is two 3.15-volt windings with one end hangin' open! (Fig. 4). Tin the ends and solder 'em together, and—

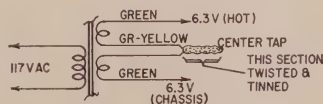


Fig. 4—Center-tapped 6.3-volt heater winding. Center tap is two leads. If you cut center tap short, be sure to solder leads together.

voilà!—you'll be right back in business!"

The Young Ham did this, replaced the tape, and once more turned the amplifier on. This time, the wattmeter rose to about 30 watts, hesitated, then kept on climbing until a reading of about 60 watts was reached. "That's more like it," said the Old-Timer, as a low hum came from the speaker. "Touch the input grid there." The Young Ham did so, and was rewarded with a loud squawk from the speaker. "Now! Now we're gittin' somewhere," remarked the Old-Timer. "Let 'er cook there for about an hour, and you're all done."

What made it blow?

The Old-Timer leaned back on his stool, with his hands locked around his knee. "Only one thing worries me," he said. "What made that transformer blow in the first place? You see, there's only two things that can burn out a transformer, and they're both overloads. One, of course, is an external overload like a shorted filter capacitor, and the other is an internal short. For instance, if the insulation broke down on a couple of turns of wire anywhere in that transformer, that's a 'shorted turn' and the current would build up somethin' scandalous in it. It'd git red hot and cause the turns on either side to break down, too, and it's jist Katie bar th' door for th' poor li'l transformer. That musta been what happened to that one. What-cha got there?"

The Young Ham had picked up a tube which had rolled behind some stuff

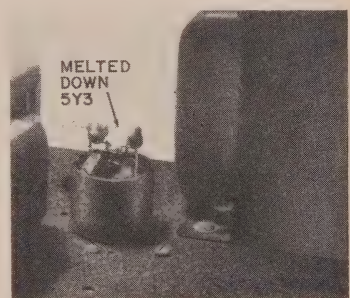


Fig. 5—The guilty 5Y3, with glass removed to show the melted parts.

on his end of the bench.

"I'll bet you this was the rectifier tube out of that thing!" he cried. "Goll-ee, look at it! What in the world happened to it?" He handed it to the Old-Timer, who looked at it and whistled. "Phew-yew! No wonder th' poor little transformer fell all to pieces! See what happened, don't you? The filament broke in two and fell over into th' plates. That started a big fat arc, and she jist sat there and melted herself down into a cute little puddle! I don't believe I ever saw one melt down that good before (Fig. 5)! Well, that's jist another darn good reason for usin' a line fuse. That thing hasn't got one on it, has it? Gosh, no!" He answered his own question. "You can see it ain't, from the shape this and th' transformer's in. Well, it'll have one when it leaves here! Is there enough room

on that chassis to put a fuse post there?"

"I don't think so," answered the Young Ham, doubtfully. "It's pretty crowded under there."

"Well, anyhow, this is a lot easier to install. Here," and he reached in a drawer and tossed the Young Ham a large line plug, "that'll do just as well. It's a fusible plug (Fig. 6). You put it on in place of the regular line plug, and put two 1-amp fuses in it, one in each side. There's a whole bunch of different kinds of those, and every amplifier or anything else with a power

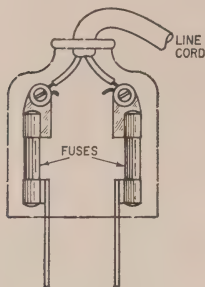


Fig. 6—View of typical fused plug for use with equipment that does not have built-in fuse protection. It is installed in place of the regular line plug.

transformer sure ought to have one! You can buy a heck of a lot of fuses for what one power transformer costs! One thing you wanta check, though—whenever you see one of 'em, look and see if some knucklehead hasn't put a 20-amp auto fuse in it instead of the 1-amp it oughta have!"

"That's a good idea, all right," agreed the Young Ham. "I believe I'll put one of those on the power supply of my new transmitter!"

"Well, whenever you replace a power transformer in *anything* around here, be sure it either has its own line fuse or one of these on it before it leaves this shop!" declared the Old-Timer firmly. "That sure saves a lot of trouble! Also, be sure to cook that thing as long as you can before the customer comes after it. All day, if you get the time. That way, if anything else is on the verge of going bad, like a weak filter capacitor or something, you've got a fair chance of catching it before it's delivered. Good reason for it too. If this poor guy has just chumped off \$18 or \$20 bucks to get the thing fixed, he's going to be a little tender around the pocketbook for a few days, and for some reason he's gonna expect th' thing to work! If it goes phoop on him, he's liable to come down here and mop up the place with both of us! And, saaaaay, you know, speakin' of moppin' up—" He glanced meaningfully around the shop. The Young Ham sprang from his stool, crying, "Quittin' time! Quittin' time!" and dashed off across the shop with the Old-Timer in hot pursuit. The clock on the wall said 4:30!

END

SHORT-WAVE FORECAST

Nov. 15-Dec. 15

By STANLEY LEINWOLL†

Most readers are probably familiar with the International Geophysical Year (IGY), the recent program in which scientists from 66 countries cooperated in a joint effort to further man's knowledge of the world in which we live.

This program was so successful that plans are now being made to conduct a "little IGY" during the coming years of *minimum* sunspot activity. Preliminary details were worked out at a recent meeting in Paris of the International Committee on Geophysics, and the name International Year of the Quiet Sun (IQSY) was officially adopted.

The IQSY will begin in the spring of 1964 and continue through the winter of 1965. Information about the sun, sunspots, the ionosphere and auroras will again be gathered by scientists throughout the world, using the latest available techniques, which will include high-energy radio waves, rockets and satellites.

The IGY studies yielded a wealth of valuable information about the earth and its atmosphere, and it is anticipated that the IQSY will yield further useful data in man's continuing quest for knowledge about his environment.

The tables show the optimum broadcast band, in megacycles, for propagation of programs between the locations shown during the time periods indicated. For example, a listener in Pittsburgh, Pa. would use the Eastern USA table. He would be most likely to hear broadcasts from West Europe in the 21-mc band at noon, and the 9-mc band at 8 p.m., Eastern Standard Time. However, day-to-day variations in receiving conditions can be large.

To use the tables, the listener selects the one most suitable for his location, reads down the left side to the region he wishes to hear, then follows the line to the right until he is under the appropriate time. (Time is given at the top of each table in 2-hour intervals from midnight to 10 pm, in *your local standard time*.) The figure thus obtained is the short-wave band (in megacycles) nearest to the optimum working frequency.

EASTERN US 10:

	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	6	6	6	9*	21	21	21	17	11	9	9	6
East Europe	7	7*	6*	9*	21	21	17	11	9	7	7	7
Northern Latin America	11	9	9	11	15	17	15	17	17	15	11	11
Southern Latin America	11	11	9	11	15	15	15*	17	17	15	11	11
Near East	7	7	6*	11*	17	17	17	11	11	11	9	7
North Africa	7	7	7	11*	17	17	15	15	11	11	9	9
South & Central Africa	9	9	7*	17	21	21	21	15	11	11	11	11
Far East	11	9	9	7	9	7*	9*	7*	9*	15	15	11
Australia & New Zealand	11	11	9	9	11	11	15*	15	15	17	17	11

WESTERN US 10:

	6*	7	7*	11*	17	17	15	9	7	6	6	6*
West Europe	6*	7	7*	11*	17	17	15	9	7	6	6	6*
East Europe	7	7	7*	7*	11	15	15	9	9	7	7	7
Northern Latin America	9	9	9	9	15	15	15	17	17	15	11	11
Southern Latin America	11	9	9	11	15	15*	17	17	17	15	11	11
North Africa	9	7	7	11	17	17	15	9	9	9	7	7
South & Central Africa	9	9	9*	15	21	21	21	15	15	11	11	11
Far East	7	7	7	7	7	9	9	17	17	17	15	9
South Asia	7	7	7	7	9	15	11	11*	15	15	15	9
Australia & New Zealand	11	11	9	7	11	11	15	15	21	21	17	15

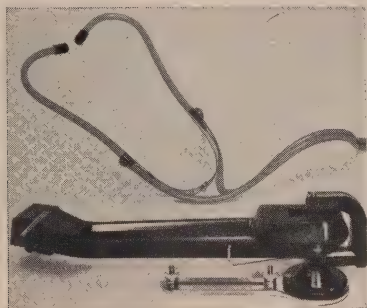
CENTRAL US 10:

West Europe	6	7*	7*	9*	21	21	17	11	9*	7	6	6
East Europe	7	7	7*	9*	15	11	9*	9*	9	9	7	7
Northern Latin America	11	9	9	15	17	17	15	17	17	15	11	11
Southern Latin America	11	9	9	15	15	17	17	17	17	15	11	11
Near East	9	7*	7*	9*	17	15	11	9	9	9	7	7
North Africa	7	7	7*	7*	17	17	17	11	9	9	9	7
South & Central Africa	9	9	9*	17	21	21	21	17	15	11	11	9
Far East	7*	7*	7	7	9	9	7*	9*	21	21	11	9
Australia & New Zealand	11	11	9	9	11	11	15*	15	17	17	15	11

†Radio-frequency and propagation manager, RADIO FREE EUROPE.

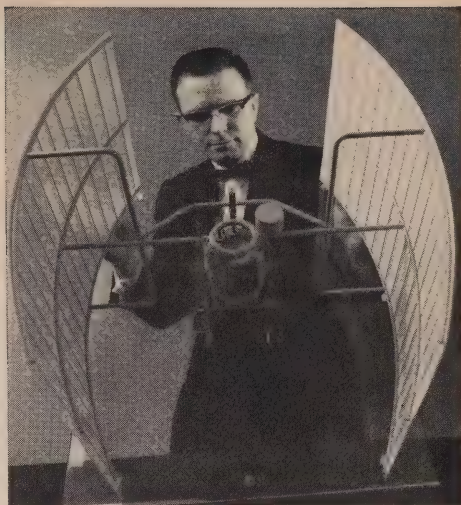
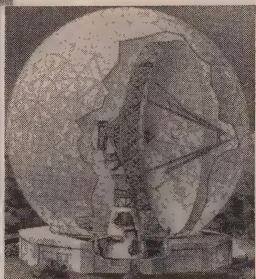
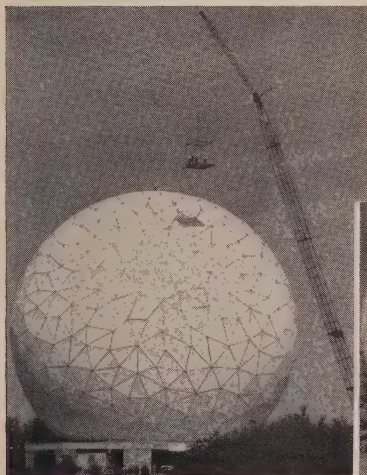
*Reception may be very poor or impossible on this path at this hour.

What's New



YOU HEAR STEREO WITHOUT ELECTRONICS when you listen to stereo records with this pickup arm. The cartridge produces audible sound which is fed through two tubes, one in each branch of the arm, and on to the headset (rear) through a length of hollow tubing. The device has individual volume controls and a blend control. The Stereophone is made in Japan and distributed in the US by Trans-National Pioneer.

BUG-EYED DEVICE measures blood circulation through the eye cavity and, by inference, blood circulation to and from the brain. The Decker Corporation makes this Ophthalmic Artery Pulsensor which delivers valuable information on vision defects and damage to the circulatory system of the brain.



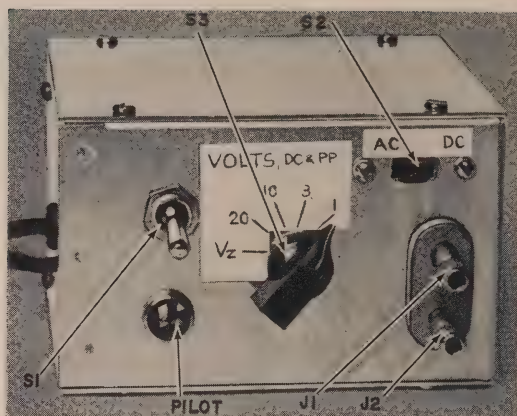
NUCLEAR THERMOELECTRIC POWER system will deliver 50-60 watts of electricity for three months on the moon's surface. The system, developed by Westinghouse, uses the spontaneous decay of a radio-isotope to produce heat which is converted into electricity by a thermoelectric system. The curved sheets at either side are waste heat radiators. A model of the system is shown here.



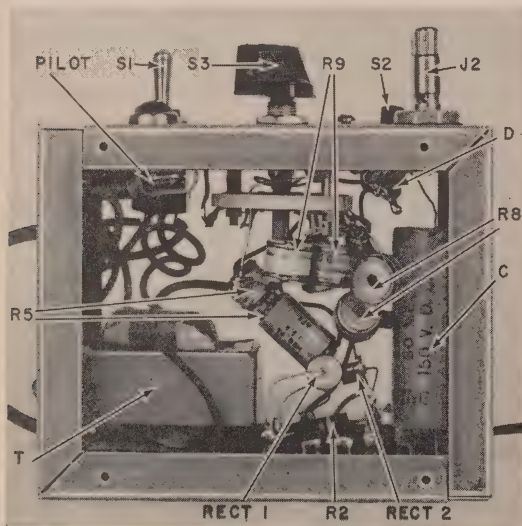
WORLD'S LARGEST RADOME, a 150-foot wide sphere, has been set up on Haystack Hill, Tyngsboro, Mass. It will house a sensitive precise 120-foot parabolic antenna (described in the October issue, page 12) for radio communications and space research. The radome was designed by Lincoln Laboratory of MIT and built by the H. I. Thompson Fiber Glass Co. under the direction of the Air Force's Electronic Systems Division.

ZENER DIODE voltage calibrator

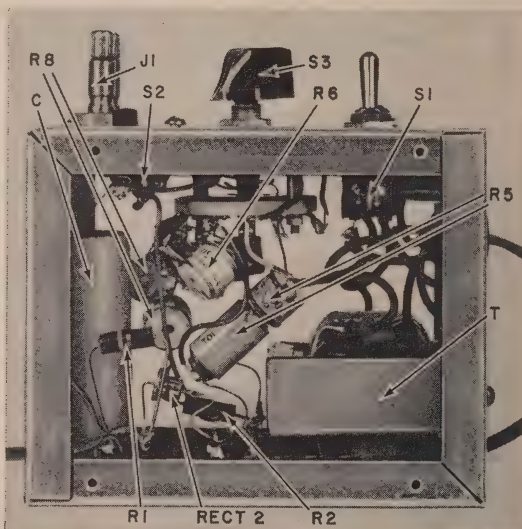
If your vtvm and scope are accurate, your measurements will be correct. You can calibrate both precisely with this simple instrument



Front panel of the completed unit.



Inside the calibrator; view from the bottom.



Inside the calibrator; view from the top.

By **PAUL S. LEDERER**

This calibrator produces dc voltages of 1, 3, 10 and 20 volts, and positive-going 60-cycle square waves of 1, 3, 10 and 20 volts peak to peak. The amplitude of these voltages is accurate within 3% and is constant within better than 1% for line voltages between 105 and 125.

The heart of the device is a Zener diode semiconductor voltage regulator. In its forward direction, it acts like a conventional silicon rectifier. Similarly, it will show a high resistance in the reverse direction for voltages up to a critical value. At that point, the Zener voltage, the diode breaks down and current flows through it in the reverse

direction. Once reverse current flows through the diode, the voltage across it will remain constant over a wide range of current. Thus the Zener diode acts as a voltage regulator. Standard commercial units are available for voltages from about 4 to 100.

To obtain accurately known dc voltages, we feed voltage to the diode through a resistor. Variations in supply voltage will cause the current through the Zener diode to vary. But as long as the current is within the Zener region, the voltage drop across the diode (Zener voltage) remains essentially unchanged.

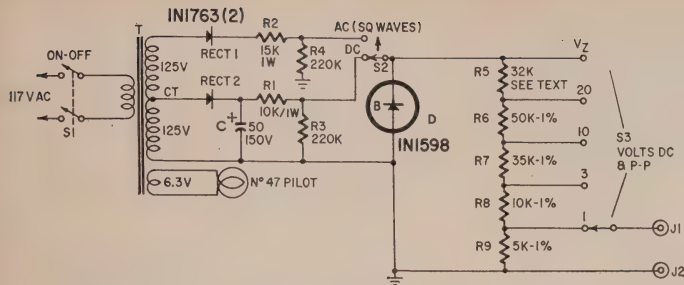
By putting a resistive voltage divider across the Zener diode, a number of voltages can be derived. To calibrate

vtvm's, it seemed desirable to have 1, 3, 10 and 20 volts. A (nominal) 27-volt 3.5-watt Zener diode was selected. This high-power type Zener diode was chosen to minimize voltage variations caused by self-heating.

Since most scopes do not have dc amplifiers, we must use ac to determine deflection sensitivity. This calibrator produces 60-cycle square waves. They are generated by a refined version of a scheme I described in the July 1958 issue of RADIO-ELECTRONICS, page 76.

How it works

Ac from the high-voltage winding of a power transformer is fed to the Zener diode through a large series resistor



Circuit of the accurate calibrator.

R1—10,000 ohms, 1 watt, 10%
 R2—15,000 ohms, 1 watt, 10%
 R3, R4—220,000 ohms, 1/2 watt, 10%
 R5—see text, value varies with Zener diode used
 R6—50,000 ohms, 1/2 watt
 R7—35,000 ohms, 1/2 watt
 R8—10,000 ohms, 1/2 watt
 R9—5,000 ohms, 1/2 watt
 C—50 μ f, 150 volts electrolytic
 D—IN1598 (1RC)
 J1, J2—terminal posts
 RECT 1, RECT 2—1N1763 (RCA)
 S1—dpst toggle switch
 S2—spdt slide switch
 S3—single-pole 5-position rotary switch
 P—power transformer: primary, 117 volts; secondary, 250 volts, 25 ma; 6.3 volts, 1 amp (Stancor PS-8416 or equivalent)
 Case, to suit
 Miscellaneous hardware

(see schematic). On the positive-going half of the cycle, voltage is applied to the diode in the reverse direction. When the positive-going voltage reaches the Zener value, the diode conducts in the reverse direction and the voltage across it remains constant at the Zener level as long as the applied ac amplitude remains above this level. During the negative half of the cycle, the diode conducts heavily in the forward direction and the voltage across it is almost zero. Thus we get positive-going square waves whose amplitude is set by the diode's Zener rating. Strictly speaking, they are not true square waves but "clipped sine waves" of trapezoidal shape. If the peak ac amplitude is about 10 times the Zener voltage, the wave-shape will be that of an excellent square wave.

During the negative half of the cycle, the voltage across the Zener diode is actually near 1 volt, which would make the total square-wave amplitude higher than the value of Zener voltage. This is eliminated by placing a silicon rectifier (RECT 1, 1N1763) in series with the dropping resistor and Zener diode. It has no particular effect on the positive half of the cycle but, during the negative half, the back resistance of the

diode is very high, more than a megohm. Consequently, most of the negative-half voltage appears across this rectifier, leaving only about 20 mv across the Zener and assuring a square-wave amplitude of precisely the Zener value.

A center-tapped 250-volt power transformer, with one end of the winding grounded, feeds 125 volts from its center tap through RECT 2 (1N1763), to supply filtered dc to the Zener diode. The other end of the winding supplies 250 volts ac through RECT 1.

A string of precision 1% resistors divides the Zener voltage down to 1, 3, 10 and 20. R5 is selected so that a previously calibrated precision vtvm reads exactly 10 volts when connected to the 10-volt output. Slide switch S2 selects dc or ac square-wave output.

The calibrator can also be used to adjust vtvm's since in a square wave the average, rms and peak values are all the same.

There are two common types of ac vtvm—those in which the indication is proportional to the average value of the rectified cycle of the applied waveform and those in which the indication is proportional to the positive peak value. Both types are generally factory-calibrated in terms of the rms value of a

pure sine wave (which is 1.11 times the average value of this sine wave or 0.707 times the positive peak value of the sine wave).

The square wave of the calibrator goes from zero to the Zener voltage. This then is its peak-to-peak value.

When coupled through the blocking capacitor of an ac vtvm, the meter sees this as a square wave going above and below the zero reference, with a positive peak value exactly half that of the peak-to-peak or dc value. When this is applied to an average-reading ac vtvm, one would expect the meter to indicate 1.11 times the average value (which is the same as the peak value of this square wave).

A commercial ac vtvm of the average-reading type indicated 10.7 volts when connected to the 20-volt peak-to-peak output tap with switch S2 set to ac. A peak-reading ac vtvm indicated 7.8 volts for the same setting (not quite the expected 7.07-volt value, calling for readjustment of that meter). END

References

Paul S. Lederer, "Add an Amplitude Calibrator to Your Scope," RADIO-ELECTRONICS, July 1958
 Zener Diode Handbook, International Rectifier Corp.
 "Some Effects of Waveform on Vtvm Readings," Hewlett-Packard Journal, Vol. 6, Nos. 8, 9, 10, 1955.

Constant-setting audio volume control

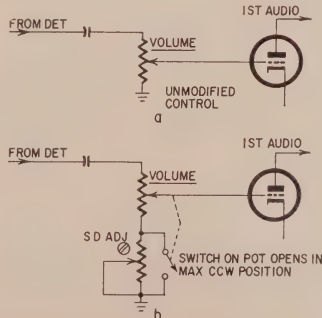
By RONALD L. IVES

IN MANY COMMERCIAL INSTALLATIONS the audio outputs of various receivers are transmitted to speakers in various locations. Each speaker, at the better installations, has its own volume control to set the audio level for that particular location.

All too often this logical system is disrupted by someone adjusting the volume on the main receiver. Then all speaker volume levels must be re-adjusted. This sometimes occurs several times during a working shift.

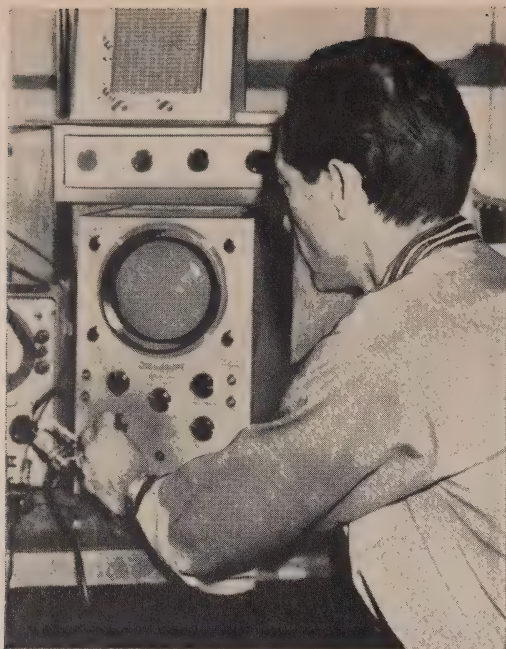
This recurrent annoyance can be eliminated by modifying the audio volume-control circuit slightly. A conventional audio volume-control circuit is shown at *a* in the diagram. The modification, requiring only an additional switch and variable resistor, is shown at *b*.

This is how the modified control works: When the knob is in any position other than OFF (extreme counter-clockwise), the control functions normally and exactly as before the



modification. When the modified volume control is turned OFF (extreme counter-clockwise), the switch opens. The volume-control circuit then becomes substantially a fixed divider, with the main volume-control potentiometer forming the upper leg and the added variable resistor (screwdriver-adjusted, inside chassis) the lower.

With this arrangement, when the speaker is feeding the lines to remote speakers, the main control is set at OFF position and the volume controls on the individual speakers regulate individual audio outputs. When the receiver is being used for other purposes, and the lines are not in use, the central volume control is used in the conventional manner. Unauthorized use of the main volume control may be prevented by a warning sign or locking device or by removing the knob, whichever may be convenient or necessary. END



FULL VALUE FROM YOUR SCOPE

Learn to take advantage of all the capabilities of your most useful instrument

By **BARRON KEMP**

THE OSCILLOSCOPE CAN PORTRAY INSTANTANEOUSLY the fluctuating circuit conditions in that dog you've got on the bench. You can use it to troubleshoot where multimeters and signal generators are stymied. A multimeter is ordinarily the ideal instrument for locating troubles such as incorrect or no voltage, short or open circuits. For other troubles, using a scope is often the easiest way to locate the bad stage. For example, hum or distortion in a receiver or amplifier output can be located quickly by connecting a scope to various points in the circuit. In the same manner, an open bypass capacitor is given away when you find a signal voltage where it shouldn't be. An example of this is at the screen grid of an amplifier where a capacitor bypasses the signal to cathode or ground. If the scope shows the signal voltage at the screen grid, there is no bypass action and the screen bypass capacitor is probably open.

A scope also helps when checking a power supply filter for open capacitors or ripple. It checks the gain of a stage by indicating the increase in signal amplitude from the grid to the plate circuit. It checks vibrator power supplies for correct output waveform, and multi-vibrator and blocking oscillator circuits where nonsinusoidal waveforms are involved. In addition, the scope is useful for determining frequency ratios by means of Lissajous figures, checking frequency response or phase shift in audio amplifiers, and checking the percentage of modulation in transmitters.

Your oscilloscope is a complicated instrument. Become familiar with it before using it so you'll use it properly and safely. The best way to do this is to read the manual on it and *think* before twisting knobs.

Never leave the brightness turned up when there is no sweep voltage. That single spot of light will burn the phosphor and ruin the CRT. Generally, scopes are used with the internal horizontal sweep operating, but some tests call for sweep off and external voltages applied to both horizontal and vertical inputs. To be safe, turn down the brightness level until the signal voltages have been applied to the inputs, then turn up the brightness just far enough to see the pattern clearly.

Avoid placing the scope where light falls directly on the face of the CRT. This will require increasing the brightness so you can see the trace despite the surrounding light. The higher the brightness level, the shorter the life of the CRT. If necessary, use a shield to block out surrounding light so that the brightness level can be kept low.

Keep the scope away from strong magnetic fields. They can distort the image on the CRT or magnetize the scope case. If this happens, the scope may be permanently inaccurate, even after it's removed from the source of magnetism.

Using your scope

It's good practice to set the horizontal frequency control so at least two cycles of the waveform appear on the screen. Also, you may find that your scope produces an inverted image because it has a different number of

amplifier stages than other scopes. This is no handicap when examining sine waves or other symmetrical waveforms. However, when doing alignment work with a sweep generator, the required response curve will appear inverted on the screen of some scopes.

Another characteristic which may vary from one scope to another is the direction of the slope of the trace for comparison of in-phase and out-of-phase signals. This can be checked easily by

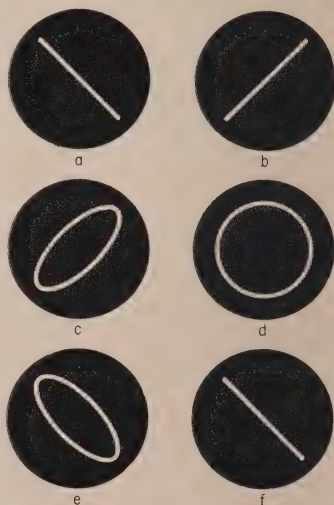


Fig. 1—Phase-angle patterns. Signal amplitudes, vertical and horizontal inputs are equal.

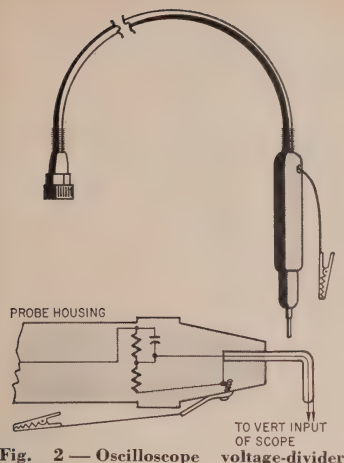


Fig. 2—Oscilloscope voltage-divider probe.

applying the same signal to both vertical and horizontal terminals with the internal sweep turned off. (The signal source can be a 60-cycle voltage taken from the test terminals on the front panel of the scope or from the secondary of a filament transformer.) The trace will slope either to the right or to the left and represents the in-phase condition. If the trace slopes to the left (Fig. 1-a), signals 180° out of phase produce a trace sloping to the right (Fig. 1-b). When two signals of equal amplitude and frequency are compared, Fig. 1-c indicates a 45° phase shift; Fig. 1-d, a 90° phase shift; Fig. 1-e, a 135° phase shift; Figs. 1-e and -f, signals of opposite polarity or with an 180° phase shift between them. If the test described for the in-phase condition shows a pattern like Fig. 1-f, then Fig. 1-e would indicate 45°; Fig. 1-d, still 90°, Fig. 1-c, 135°, and Fig. 1-a, 180°.

Misleading information is sometimes presented on the CRT because of interference from external sources. Connect the scope to a ground point on the equipment you're testing. Be careful that the stray electric fields do not come close to the CRT. Such fields can also be picked up through your body as you handle the test leads. The condition becomes more troublesome when examining low-level signals with the gain of the scope amplifiers near maximum. To minimize the effects of such stray electric fields, avoid holding the test leads. Instead, clip them into the circuit and then examine the pattern. Avoid using too much gain and keep the input signal low, or overloading may distort the waveform.

Sometimes it's necessary to use a voltage-divider probe like the one shown in Fig. 2. It prevents overloading the oscilloscope amplifiers with high input-signal voltages. The probe cuts down the signal by a known amount so a true evaluation of signal amplitude is possible. The probe also isolates the scope from the circuit you're testing for minimum circuit loading. Capacitive loading can be minimized by adding a

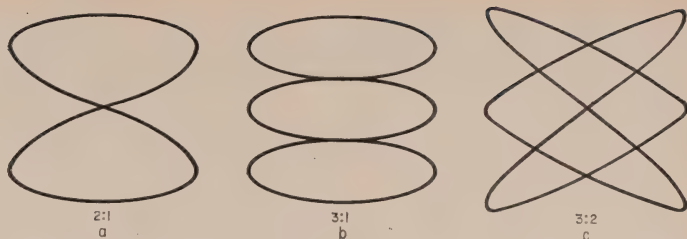


Fig. 3—Lissajous figures for frequency ratios. a—2 to 1. b—3 to 1. c—3 to 2.

resistor in series with the hot test lead if you don't have a probe.

Measuring frequency

One important function of your scope is measuring frequency. When two sine-wave voltages are applied to the scope's deflection system, one to the vertical input and the other to the horizontal input, the resultant pattern is called a Lissajous figure. Fig. 3 shows three Lissajous figures for ratios commonly encountered in frequency measurement. The ratio of the two frequencies can be determined by counting the number of loops along the right and top edges and substituting the results in the formula:

$$\frac{\text{frequency on horizontal axis}}{\text{frequency on vertical axis}} = \frac{\text{number of loops on right (or left) edge}}{\text{number of loops on top (or bottom) edge}}$$

If the frequency of one signal is known, the frequency of the other signal can be easily determined from the frequency ratio. Usually the known signal is applied to the horizontal channel and the unknown signal to the vertical channel. The shape of the pattern changes with the phase relationship between the known and unknown relationship.

Accuracy of this method is limited to the accuracy of the known frequency. These patterns sometimes change because of slight deviations in phase and frequency between the reference and the signal under test. Pattern drift and the consequent difficulty in counting limit this method of frequency measurement to a practical ratio of 10 to 1. However, if extreme care is taken in counting and if the gain of the scope is increased, it is possible to count as many as 30 loops.

Square-wave testing

You can use the scope and a square-wave generator to check frequency response, phase shift and transient response of an amplifier by using the arrangement shown in Fig. 4-a.

First, the square-wave output of the generator is viewed on the scope. Adjust the horizontal sweep so at least two full cycles can be seen on the screen. Then connect the scope to the loaded output of the amplifier under test so that the modified square wave can be viewed on the screen for comparison with the unmodified output of the signal generator. Figs. 4-b through 4-j show possible output waveshapes.

Rounding of the leading edge of the

square wave (Fig. 4-c) indicates a drop in gain at high frequencies. Such rounding is generally seen when there is a substantial drop in the gain by the tenth harmonic (or less). So if a 2-kc square wave is reproduced on the scope without rounding, the amplifier is flat to 10×2 kc, or 20 kc.

Fig. 4-d shows the effect of increased gain, and 4-e the effect of decreased gain at the square-wave frequency. Fig. 4-f indicates lowered gain at a narrow frequency band. If the square-wave frequency is brought into this narrow frequency band, Fig. 4-e results.

The result of phase shift in the

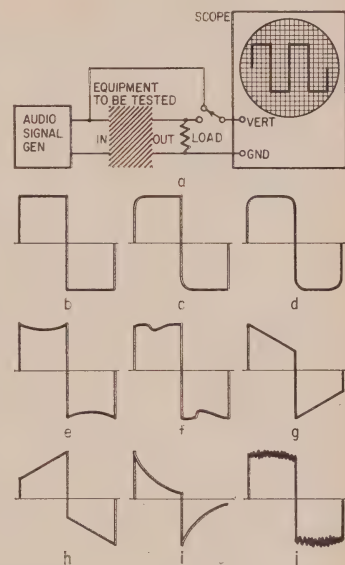


Fig. 4—Connections for square-wave testing of amplifiers; b to j—nine possible waveform distortions caused by amplifier circuit defects.

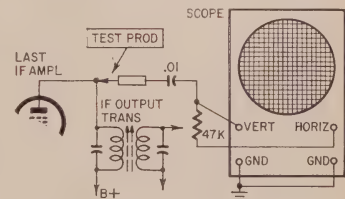


Fig. 5—Hookup for percentage of modulation measurement.

amplifier is shown in Figs. 4-g and 4-h. If, at low frequencies, there is phase shift in the leading direction, the top of the square wave will be tilted as in Fig. 4-h. The steepness of the tilt is proportional to the amount of phase shift. Although phase shift is not important in audio amplifiers, even though the ear is somewhat sensitive to it, it should not be tolerated in television and oscilloscope amplifiers.

Fig. 4-i shows the pulse output from the amplifier resulting when the square wave has been differentiated. This will happen when the value of the grid resistor or the coupling capacitor is low or if the coupling capacitor is too low or partially open.

Fig. 4-j shows a square wave with damped oscillations following the leading edge. This results when a high-frequency square wave is fed to an amplifier in which distributed capacitance and lead inductances resonate at low frequencies. In television and oscilloscope amplifiers, this can result from an undamped peaking coil.

You can give hi-fi audio amplifiers a rapid check by testing first with a

amplifier input. Set the generator output to an ample value but do not overload the amplifier. Feed the square-wave signal to the amplifier input and connect the scope across the amplifier load. Use the internal linear sweep to observe the waveform. The tone controls have a marked effect on square-wave response, so set all tone controls to their flat position unless you definitely wish to observe their effect. Also remember low-fidelity and PA amplifiers will not reproduce the square waveform.

You can test video amplifiers in the same manner as audio amplifiers, but the test frequencies might be 60 cycles for the low end and 25 kc for the high.

Determining deflection polarity

Some patterns, such as a simple sine wave, may show a distorted upper or lower half. The trouble cannot be definitely traced to its source unless the input polarity of the scope is known. Therefore, turn off the horizontal sweep and reduce the intensity (to protect the screen from being burned) to the point where you can barely see the spot of light. Turn the focus control to a

the input polarity is negative. If the opposite is true, the scope has a positive input polarity.

Measuring modulation

The oscilloscope is widely used as an amplitude-modulation measuring instrument. Since it can present visual indications of the modulated output of AM transmitters, it is a fairly reliable instrument for detecting overmodulation and determining percentage of modulation. One method of measuring percentage of modulation uses a receiver tuned to the transmitter frequency. Connect the oscilloscope as shown in Fig. 5 and retune the if stage to compensate for the additional loading. The oscilloscope pattern of an unmodulated carrier is a flat ellipse (Fig. 6-a) resulting from the phase shift produced by the horizontal amplifier input capacitance and the 47,000-ohm resistor. This line broadens with modulation (Fig. 6-b). For 100% modulation, the unilluminated area center of the pattern decreases to zero. Overmodulation (Fig. 6-c) goes beyond this point and a bright spot appears in the center

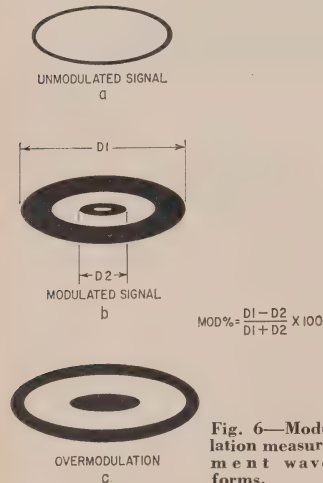


Fig. 6—Modulation measurement waveforms.

square wave of fundamental frequency not less than three to four times the low-frequency limit of the amplifier (3-db points), then with a square wave of fundamental frequency between 1/100 to 1/10 of the high-frequency limit of the amplifier, depending upon how many harmonics are considered necessary to produce an acceptable version of a square waveform. Square waves of fundamental frequency from 40 to 60 and 1,000 to 2,000 cycles are usually used to cover the range up to 20,000 cycles.

To insure correct results, connect the proper load across the amplifier output terminals and use low-capacitance cable to connect the generator to the amplifier input. If the amplifier has a high-impedance input, use a 1-megohm isolating resistor between the generator and the amplifier, shunted by a .001- μ f capacitor if there is capacitance at the

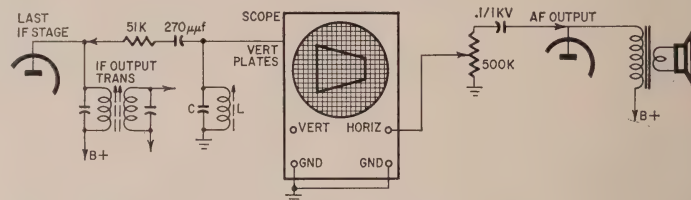


Fig. 7—Setup for producing trapezoidal modulation patterns at receiver.

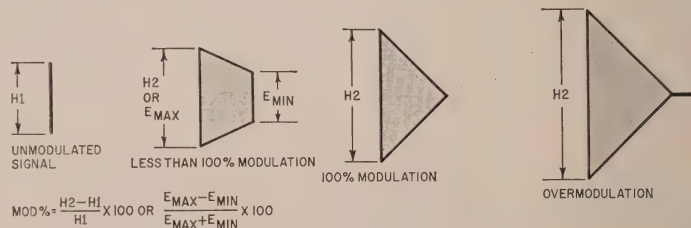


Fig. 8—Trapezoidal patterns representing different degrees of modulation.

position that makes the spot as large as possible, and the vertical gain control to its maximum clockwise position.

Now connect short pieces of insulated wire to the vertical amplifier terminals. Touch the two leads momentarily and simultaneously to the terminals of a 4- or 6-volt battery. The spot will jump either up or down, then return slowly. It jumps because the battery charges the vertical input blocking capacitor, which then slowly discharges. Next, touch the wires together to discharge the capacitor completely. Reverse the connections to the vertical terminals and connect them to the battery. The spot will now jump in the opposite direction. Note the polarity of the battery that makes the spot jump up. If the negative side of the battery is connected to the hot terminal of the scope's vertical input and the positive terminal of the battery is grounded,

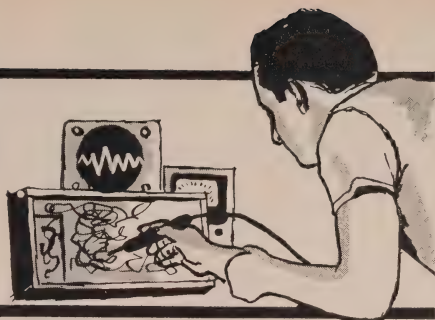
of the pattern. The percentage of modulation may be determined by the formula given in the illustration.

Trapezoidal modulation patterns may be obtained with the hookup in Fig. 7. The scope's vertical deflection plates are fed the if carrier from the plate of the if output stage, and the horizontal plates or amplifier is fed a small portion of the audio signal from the receiver's af output stage. Tuned circuit L-C is peaked at the receiver's if to provide maximum rf input to the scope.

Fig. 8 shows trapezoidal modulation patterns. Adjust the coupling to the if amplifier so an unmodulated carrier produces a vertical line somewhat less than half the screen diameter. If a direct connection to the if plate produces too much vertical sweep, make the connection to a gimmick around the plate lead. Adjust the potentiometer for satisfactory horizontal sweep. END

SERVICE CLINIC

Conducted by
JACK DARR
SERVICE EDITOR



This column is for your service questions. We answer them free of charge and your name and address will be kept confidential if you wish. The main purpose is to help those working in electronics with their problems.

We've changed our target a little and are no longer restricted to TV. Radio, audio and industrial electronics problems are also grist for the mill. All letters get a prompt individual answer and the more interesting ones will be printed here. So if you have a service problem, send it here. We'll do our very best to help you solve it.

I've noticed a lot of cases lately where the trouble being described seems to center around defective electrolytic capacitors. So this might be a good time to work over a few characteristics of electrolytic capacitor troubles and give some cures for them.

There are two defects in electrolytics—shorts and opens. If you can't locate a shorted unit, we just won't bother with you any further. However, open electrolytics can cause some strange and wonderful symptoms!

In addition to the completely open unit, you'll find some that are only partly open—decreased capacitance or filtering efficiency. The power factor of an electrolytic determines its filtering efficiency. Actually, the power factor is just about proportional to the leakage through the capacitor, so we can use the leakage as a sort of guide to the condition of the capacitor. This leakage has the same effect as a resistor shunted across the capacitor. Of course, this fouls up the voltage ratios in all the voltage-divider circuits in many TV receivers and away we go.

The completely open capacitor we can locate by bridging or shunting (whichever term you prefer). The partly open, low-capacitance or high-power-factor electrolytic very often defies diagnosis by this method! So to be perfectly sure, open a suspected capacitor completely, then connect your substitute.

The scope is about the handiest tool to use for this kind of diagnosis. By connecting a low-capacitance probe across points in a circuit suspected of harboring undesired hash or feedback, we can locate it in a matter of minutes. Leaving the scope connected while a good capacitor is bridged across the suspected unit will almost always give us a pretty good idea of what's going on in the circuit. If you can't tell whether or not the hash seen is too high in amplitude, shunt the nearest capacitor and watch the scope. If the hash drops to a thin horizontal line, and at least

some of your symptoms clear up at the same time, you're making progress.

For instance, if you have a shadowy hum-bar on the screen, one so faint that you really can't tell whether it's definitely there, check the ripple level at the output of the filter. It ought to be somewhere around 0.2 to 0.5 volt peak to peak (p-p); very little more. So if you find say, 5 or 6 volts p-p at the filter output, shunt the output filter capacitor and see what happens to the ripple. Also, go out along the circuit, say to the audio plate, video plate, CRT grid, and check for any trace of 60- or 120-cycle signal there. Watch these while shunting various capacitors. They'll tell you whether the electrolytics are ripe for replacement.

We left the worst until the last—the intermittent electrolytic. These do not seem to be as common as they once were—but like relatives, they pop up when you least expect them. I'd say that improvements in manufacturing have done more good than anything else in reducing this trouble.

All of us at one time or another have had the happy experience of an intermittent electrolytic closing up firmly after another unit was shunted across it and working perfectly for a long time. The only way to get a reliable check on such a condition is to sneak the replacement capacitor into the circuit. Several people make capacitor substitution boxes with built-in provisions for this. You can do the same thing by connecting a potentiometer, about 500,000 ohms, in series with the shunt capacitor. Connect this into the circuit, then reduce the resistance in the circuit until the new capacitor is directly across the suspected points. This, together with your scope will tell you what's going on.

There are quite a few rough checks that can be applied to localize possible trouble spots in this department. One of them is heat. Feel a suspected capacitor with your fingers. If it is unpleasantly warm, look out. This is as-

suming that the capacitor is not located near any source of heat, such as the 5U4, horizontal output tube, etc.

The heat here is caused by excessive leakage current through the capacitor, causing an internal temperature rise. This results in a fast boiling away of the electrolyte, and an open capacitor. Actually, a so-called dry electrolytic isn't any drier than a dry-cell flashlight battery. They're both damp. Without water in some form or other, both of these devices would fail. The major activity in both capacitor and battery is chemical, and water is a necessity.

A hot capacitor should be carefully checked for capacitance, leakage and power factor. If it shows bad, and it is located near a source of high heat, don't hesitate to relocate it—if there is any room on the chassis. The high ambient temperature has probably hastened the downfall of the original unit.

Color drift

In an Admiral, model C322C2 color TV, the screen has a decided magenta tint when it first comes on. After about 2 minutes, it makes a pretty good black-and-white picture. If I set the green screen and grid controls with the set cold, the picture is OK, but it gets greenish after it is thoroughly warmed up.—R. P., Clio, S. C.

From the symptoms, there is only one thing wrong with it. When cold, you don't have enough green—in the monochrome raster, that is. Obviously, something is reducing the amplitude of the green gun's output. After warmup, the green gun comes up to normal.

I'd say that this was a defective

(Continued on page 64)

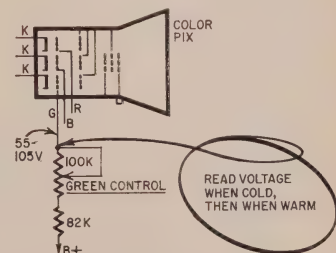


Fig. 1—Check grid and cathode voltages on the color crt to find out which one is causing the color temperature drift.

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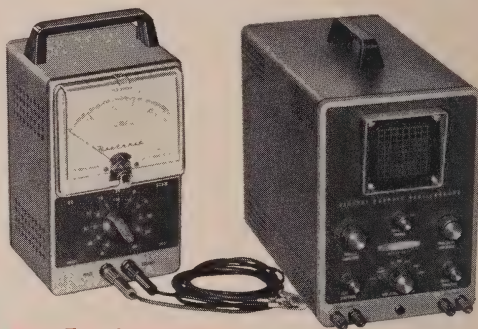


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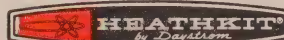
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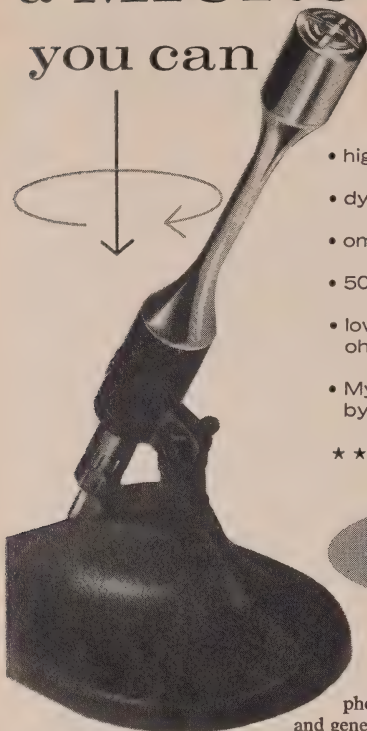


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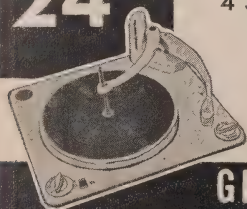
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(Continued from page 61)

resistor. Also, it is somewhere in the green grid or screen circuit: (Fig. 1). Hook a dc vtvm to the green cathode or grid, preferably the grid, and turn the set on. This voltage ought to read between 55 and 105, depending on the position of your controls—brightness, contrast, etc. Leave all controls alone and see what happens as the set warms up. If the green grid voltage drifts quite a bit, the trouble is bound to be in one of the resistors in the supply circuits. If the green stays the same, check the other grids. Since this set, like many others, does not amplify the green directly, but makes it out of the blue and red, matrixing it between the R—Y and B—Y amplifiers, there is a possibility that one of the other two is slightly slow heating. Measure all of the grid and cathode voltages on the CRT and check out the circuit which shows the drift.

Sweep-alignment query

There is something I'd like to know about sweep alignment. Some manufacturers recommend connecting the sweep generator to the antenna. After all, it's the combined tuner-if response that determines picture quality, isn't it?

The normal effect of the fine tuning control is to move the video and sound markers along the curve. This is also what we are trying to do when we align a set, isn't it? So, the question is, where should we set the fine tuning before starting the overall response curve check?—G. B., Hoisington, Kan.

Let's go back a little and straighten something out before answering this fully. The results you get when making sweep-alignment adjustments depend on your concept of their purpose. So, let us take a look at that first.

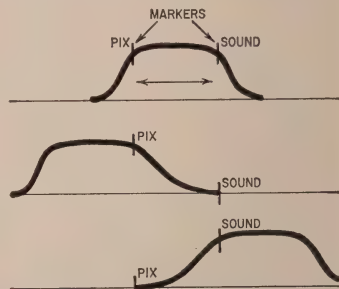
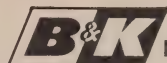


Fig. 2—Oscillator frequency adjustment moves the curve from side to side. The markers stand still.

If we display a sweep response curve of a TV set on a scope, we put marker frequencies on it to be able to identify certain particular frequencies. These markers are always fixed. If we change the oscillator frequency of the TV set, we'll move the curve from side to side, but the markers will stay right where they are (Fig. 2). We can do the same thing by tuning the sweep generator, of course. However, after we get a curve on the scope, we can move

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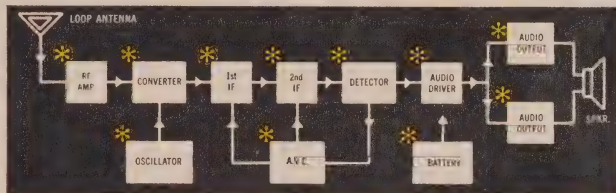
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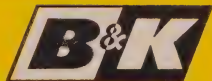
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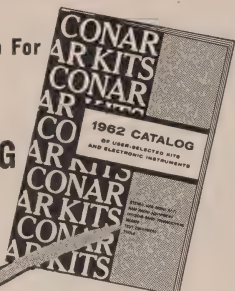
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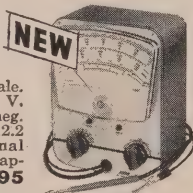


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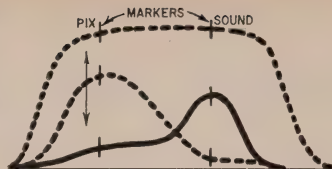


Fig. 3—Alignment adjustment moves the markers up or down. The curve stands still, although its shape changes.

the markers, but only up or down. We do this by tuning the if, tuner, etc., which alters the amplitude response of the circuits at certain frequencies (Fig. 3). So always remember this principle. Oscillator or sweep-generator adjustments move the *curve* from side to side. Tuning or alignment adjustments move the *markers* (or, to be precise, the portion of the curve where the markers are seen!) up or down, never sideways!

Finally, to answer your question, your fine-tuning adjustment should be set in the center of its range and left alone during the whole alignment process. Final adjustment of the tuner oscillator slugs, etc. should be made on a TV station signal for best picture and sound. If the fine tuning is centered, the user has the maximum range of adjustment after you finish.

Vertical bars

I am servicing an Emerson 120245D

which has alternating light and dark bars running from top to bottom of the screen. These seem to overlap the picture and are not changed by the contrast control. They are about 2 inches wide with normal picture brightness between. All voltages check out, and nothing shows up on a scope. Edges of the raster are straight.—B. H., East Moline, Ill.

I gather from your description that the bars are about equally spaced all the way across the screen. If they were heavier at left, fading out toward the right, this would be plain old yoke ringing. However, I believe this is something else. I have encountered this trouble before, although not in the same make set, and it is quite rare.

Check the balun coil between the antenna and the tuner. A certain combination of broken wires on the coils will cause a weird sort of unbalance here, and the antenna lead will pick up the 70-kc harmonic radiation from the flyback-yoke system. This causes the alternating bars across the raster. A break in one of the conductors of the lead-in, near the set, will do the same thing.

One other thing might be of some assistance, if the balun is OK. Shield the yoke leads by wrapping them with aluminum foil. Ground the foil by wrapping a bare wire spirally around the cable, fastening it to the yoke bracket at one end and the chassis at the other. Don't let it get too close to the yoke terminals, or you might get flashover.

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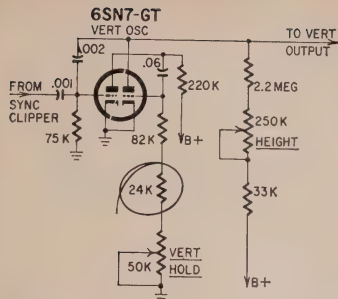


Fig. 4—Vertical oscillator circuit of G-E 810. Juggle circled resistor to stop picture rolling.

Be sure that the high-voltage shield (the doghouse) is in place and well fastened.

Vertical roll

I'm working on a G-E 810. The complaint is a vertical rolling, but I've checked all voltages and resistances, and they seem to be within the tolerance. I've changed the tubes, with no results.—F. A., Los Angeles, Calif.

This type of vertical oscillator is very common in all kinds of TV sets (Fig. 4). First check or replace all capacitors that show even the slightest sign of dc leakage. Even a very small dc leak will make this oscillator circuit hard to hold.

Next check the resistance values,

especially plate load and grid resistors. In this particular chassis, if everything else checks out, juggle the value of the 24,000-ohm resistor in the grid circuit of the second triode section till you get the picture to stop with the hold control somewhere near the center of its range. You might even replace the hold control with a slightly larger unit.

New CRT

What changes would be necessary in a G-E 21T25 so that a 21ZP4B could replace a 21ARP4?—R. E. H., Fitchburg, Mass.

You can use the 21ZP4B as a replacement for the 21ARP4 by simply providing some means for focusing the tube. The 'ZP4 tubes are magnetic-focus types, so you have to add an EIA No. 109 focus coil (or its PM equivalent).

I have a better suggestion: a type 21JP4 is an exact replacement for the 21ARP4. However, a 21XP4 or 21YP4 would be less expensive for replacement purposes; both of these are electrostatically focussed tubes. Run a wire from pin 6 of the tube base to some point in the circuit; use whatever dc voltage gives the best focus (anywhere from +250 volts to ground).

White streaking

The set in question is a General Electric M4 chassis. After it is on for 5 minutes or so, small white "pellets" streak across the screen. In a short while the interference resolves itself

into a jagged white bar about 1 inch in width. It looks like Barkhausen or spook interference, with one difference, it flits back and forth across the face of the screen. With no picture content the bar disappears. Could it be a parasitic oscillation in the horizontal system? I can get no help on this from anyone.—W. E. G., Bronx, N. Y.

This interference is undoubtedly related to the horizontal system and is getting into the video as you say, with a blank raster, the phenomenon disappears. You'll find the same thing in some sets with black dots and streaks instead of white. It depends on the polarity of the signal which is being picked up and at what point in the circuit the pickup takes place.

This is usually due to parasitics in the horizontal sweep circuits. These can be eliminated by inserting small (47-ohm) resistors in series with the output tube plate and screen leads, or by using small well-insulated rf chokes (such as the type used in some TV set heater circuits).

It can also be due to radiation from the sweep circuits getting into the antenna lead to the tuner. Dress this lead as far away from the horizontal system as possible and secure all shielding (the doghouse, etc.). Now and then a set comes in without the doghouse; some careless technician has left it off completely! In a case like this, replace it, either by getting a duplicate or making one out of copper screening. **END**

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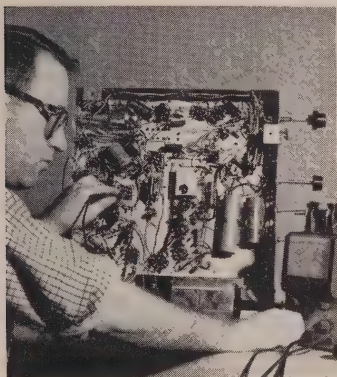
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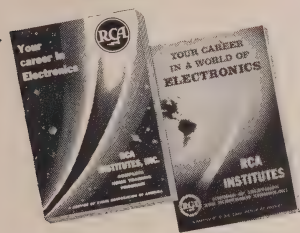
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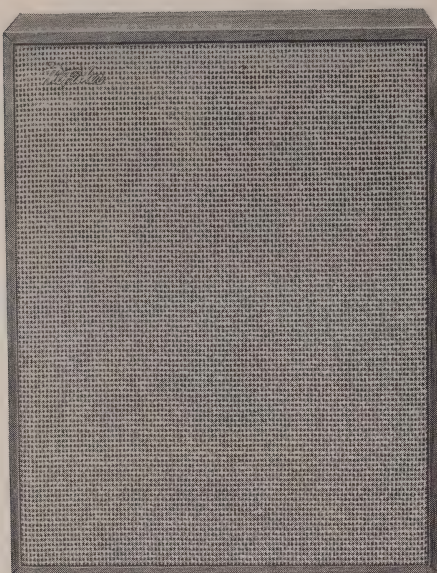


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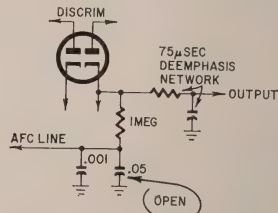
FM tuner problem

By HERMAN BURSTEIN

SOME of the toughest service problems involve electronic units that are just a bit out of kilter rather than completely out of commission. One is particularly likely to run into this kind of situation with hi-fi components. The owner often considers even a slight departure from perfect performance equivalent to outright failure. He may complain about something that extremely careful listening barely reveals. (And you can't blame him, because he has paid a good deal of money for the difference between adequate and excellent performance.) Confronted with a service problem of this kind, the technician has to adopt the audiophile's viewpoint or get out of the hi-fi business.

This is illustrated by the case of an FM tuner of excellent reputation that was brought in for servicing. The sequence of events was:

1. *Customer:* Complained the tuner did not reproduce bass as well as it used to.
2. *Technician:* Fed the tuner signal into a test amplifier and speaker, the latter an 8-inch unit in an enclosure of about 2 cubic feet. Tuner sounded satisfactory to him, and he said so.
3. *Customer:* Protested that the test



speaker was inadequate for low frequencies, compared with the speaker system in his home.

4. *Technician:* Went to special effort of feeding the tuner signal to a large speaker system with bass response beyond dispute. Tuner again sounded all right to him, and he said so.

5. *Customer:* Still insisted that the bass was not what it used to be.

6. *Technician:* Hooked up a test FM tuner of very good make to the amplifier and switched alternately between the test tuner and the customer's tuner

on the same stations. There was no apparent difference on the first couple of stations. Then he tuned in a symphonic recording containing passages with full bass. Now there was a definite difference. The test tuner had solid bass with considerable impact. The customer's tuner sounded wan at the very low end. The technician accepted the tuner for servicing.

7. *Technician:* First thought that the tuner's output coupling capacitor had dropped appreciably in value, reducing bass output. But a check of the .05- μ f output capacitor proved it was perfectly all right. With the usual input resistance of about 500,000 ohms presented by most preamplifiers, this would insure bass response flat within 1 db down to about 13 cycles.

8. *Technician:* Cogitated for a while. Referred to schematic. Cogitated some more. While listening to a program with appreciable bass content, he flicked the afc switch to the off position. Immediately the bass improved. He checked the parallel .05- and .001- μ f filter capacitors in the afc line, shown in the diagram. (The .001- μ f capacitor, ceramic, insures filtering of the high frequencies, which may be inadequately shunted to ground by the larger capacitor owing to its inductance.) The .05 capacitor proved open.

For proper afc action, the signal reaching the reactance tube must be dc—either negative or positive, depending on whether the tuner is set above or below the FM station's center frequency. If an ac (audio) frequency reaches the reactance tube, it causes the oscillator frequency to swing in step with the frequency deviations of the incoming FM signal. Therefore frequency deviations are reduced, causing lower audio output, which varies in magnitude with the amount of frequency deviation.

In the case illustrated, where the .05- μ f capacitor was open, the time constant of the .001- μ f capacitor and the 1-megohm resistor in the afc line was too small to shunt the low audio frequencies to ground. Therefore these low frequencies were reaching the reactance tube, causing loss of bass for the reason explained.

9. *Technician:* Put in a new .05- μ f capacitor. Now bass was as good with afc on as off.

10. *Customer:* Listened to the repaired tuner. Nodded happily, cheerfully paid his bill, and walked out satisfied he had found the right man for servicing the hi-fi systems owned by him and his friends. END

Canada Approves Stereo

The Board of Broadcasters of the Canadian Board of Transport has approved standards for FM stereo identical to those adopted in the United States. Up to the time of writing, no information on the number of stations expected to broadcast stereo in Canada was available. Some Canadian manufacturers are already making multiplex adapters and receivers.

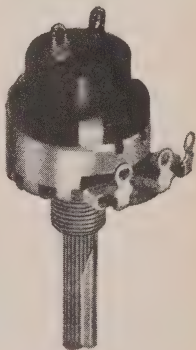


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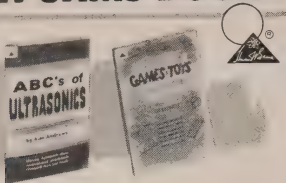
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By MARTIN H. PATRICK

A SINGLE transistor acting as a photocell can be used to convert a microammeter into a supersensitive relay which operates at the unusually low current of 5 μ a. It takes a little work, but the results are worth the trouble.

If you have a meter that has been abused by too much pegging or if you feel you would like to tamper with that old one that has seen better days, give this stunt a try. Drill a 5/64-inch hole through the face of the meter at a point where the needle movement will produce the greatest amount of light shading (Fig. 1-a). The hole must extend through the back of the meter where a pilot light is set up to provide the necessary illumination (Fig. 1-b). To do this, you will have to remove the meter from its case. Careful planning and handling will get the hole in the right spot.

A power transistor such as Lafay-

ette's SP-147 (77¢) makes an effective photocell for this application. Carefully remove the top of the transistor's case by drilling a ¼-inch hole close to the outer edge, away from where the germanium wafer is. Look for an indentation under the mounting base. The wafer is right above it. Then, with sharp wire-cutting pliers cut away the top, being careful not to damage the wafer. It's a good idea to anchor the transistor rigidly by its edge in a vise. [A cadmium sulphide or other commercial photocell might also work.—Editor] A good photosensitive transistor develops about 0.5 ma when connected as shown in Fig. 2 and exposed to a 100-watt lamp.

Some power transistors have more leakage than others. Therefore, it may be necessary to compensate for this by shunting the transistor's emitter and collector with a suitable value resistor. To determine what value to use, try a few resistors and select the one that lets the relay open when the light beam

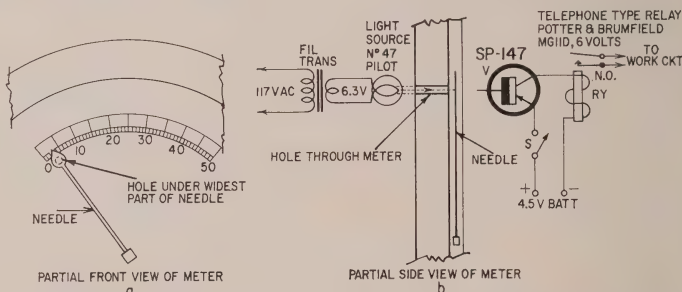


Fig. 1-a—Drill a hole through the face of the meter so that the meter needle will cover it as it moves up scale. b—Circuit of the ultrasensitive relay.

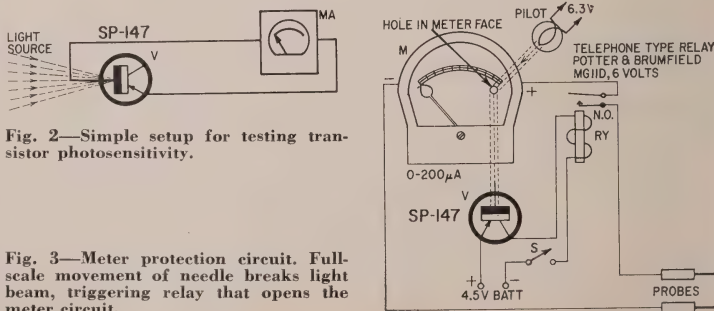


Fig. 2—Simple setup for testing transistor photosensitivity.

Fig. 3—Meter protection circuit. Full-scale movement of needle breaks light beam, triggering relay that opens the meter circuit.

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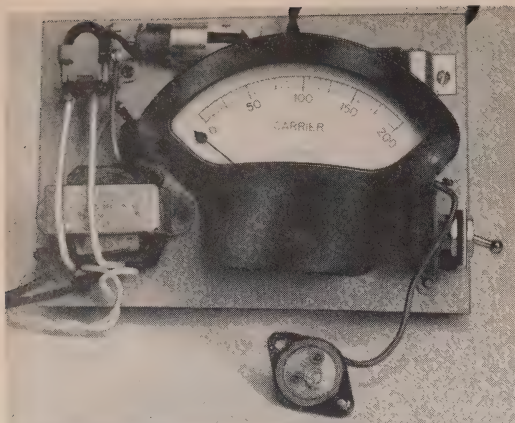
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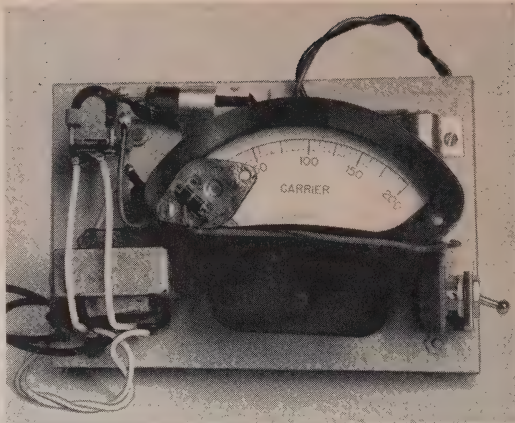


Relay is in closed wood box so line-cord connections to filament transformer are not exposed. Note power transistor with top off.

is interrupted by the meter needle.

Mount the transistor on the front of the meter in line with the hole. The meter needle should interrupt the light beam shining through the hole. By adjusting the meter movement, you may be able to actuate the relay at perhaps an even smaller current. If you intend to use the relay as a permanent setup, insert a very fine wire in the light hole to act as a stop for the meter pointer. This will insure actuating the relay at higher currents that would normally move the pointer past the hole.

The same arrangement can be used to protect a sensitive microammeter against pegging—the result of unexpected overloads or accidental shorts. Simply drill a small hole at or near the full-scale reading and use the same circuit arrangement as for the sensitive relay. Relay contacts are used as part of the microammeter circuit, in series with work under test (Fig. 3). As soon as needle movement caused by an overload breaks the light beam, the relay contacts open, thus opening the meter circuit and preventing the needle from



The 5- μ a relay with the transistor placed so the light coming through the meter face strikes the germanium wafer.

banging full scale. The relay will have to be a latching type.

The uses for this type of super-sensitive relay are numerous. For example, a powerful local station that will produce about 5 μ a (rectified) in a resonant circuit can actuate the relay. It is especially useful with thermal electricity. Almost any two dissimilar metals twisted together and heated will produce 5 μ a or more. Or you can use a PM speaker with one stage of audio amplification to make a sound-actuated relay.

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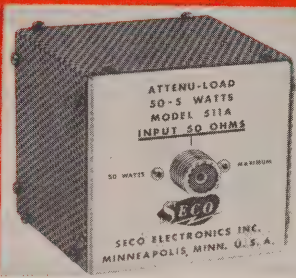
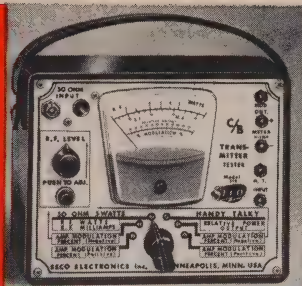
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NEW CB XMITTER TESTERS



By WAYNE LEMONS

Just how efficient is your Citizens-band rig or amateur transmitter? How efficient is your antenna as a radiator? Or what's your percentage of modulation—talk power? Without some sort of test equipment it is a virtual certainty that you have no idea. Some new equipment designed to answer these questions has just been introduced.

These new instruments cover 3 to 180 mc, so they can be used to test the bulk of AM transmitters in use today.

The model 510 transmitter tester measures power output up to 5 watts and, with the model 511A Attenu-Load as an accessory, up to 50 watts, it measures modulation percentage of both positive and negative peaks. It can also act as a dummy load.

The 520 antenna tester is a standing-wave-ratio indicator that determines antenna efficiency. All three are made by Seco Electronics.

How they work

The model 510 transmitter tester is an absorption type wattmeter (Fig. 1). Transmitter power is dissipated in a 51-ohm resistive load. Diode D1 rectifies an rf sample and the resulting dc goes through an rf filter and calibration control to a meter calibrated in watts.

With the selector switch in position 1 or 2, for checking modulation percentage on negative or positive peaks, the rf is fed through D4 in series with an RF LEVEL control (Fig. 2). With the pushbutton depressed, the rectified dc goes through an rf filter to the meter. The RF LEVEL control is adjusted until the meter reads at the RF SET position. When the pushbutton is released, a 5-μf capacitor is inserted in series with

(Continued on page 80)

An rf and modulation tester for high- and low-power rigs, plus an antenna checker and standing-wave meter speed analysis and servicing.

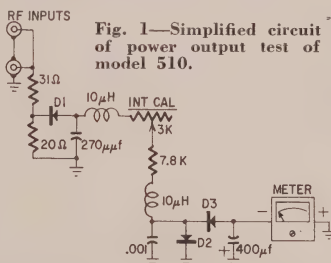


Fig. 1—Simplified circuit of power output test of model 510.

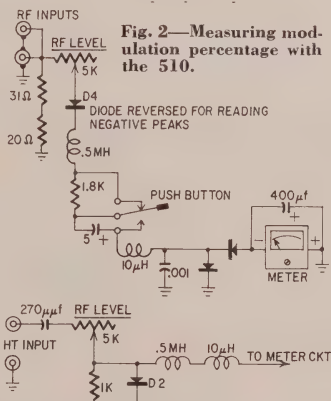


Fig. 2—Measuring modulation percentage with the 510.

Fig. 3—The 510 uses this relative power circuit for checking output of low-power units.

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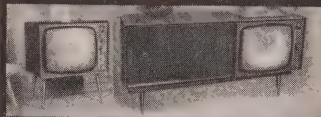
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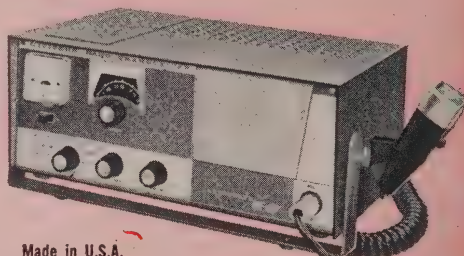
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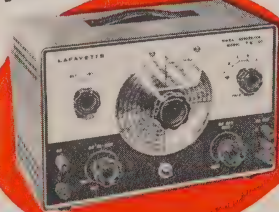
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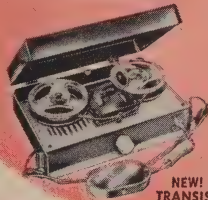
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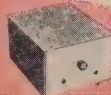


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the rectified dc. Now there is no meter reading from a steady carrier but, when the carrier is modulated, the audio component deflects the meter. This is the modulation test. By reversing diode D4, both positive and negative peaks can be read.

On low-power rigs that do not have 50-ohm outputs, the rf is coupled in as shown in Fig. 3. Only relative power measurements can be made here. Coupling to these must be kept low (small meter readings) so they are not loaded too heavily. Modulation is read as a percentage of this low reference level (Fig. 4).

For higher-power transmitters, the model 511A Attenu-Load must be placed in the feed line between the transmitter and the 510. This enables the two instruments to measure rf output up to 50 watts, as well as modulation percentages. Fig. 5 shows the Attenu-Load circuit.

The model 520 antenna tester is a directional rf indicating device. Its basic circuit is shown in Fig. 6. A directional coupler which is a short section of air-dielectric transmission line is inserted in series with the feed line to the antenna. Two back-to-back indicating circuits are coupled inductively and capacitively to the short section of transmission line in the 520. They are arranged so that one indicates the power going to the antenna while the other indicates the power reflected from it. If the outgoing (forward) power is high as compared with the returning (reflected) power, the efficiency of the radiator (antenna) is good. This is a

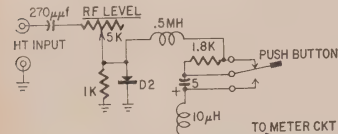


Fig. 4—Low-power modulation-indicator circuit.

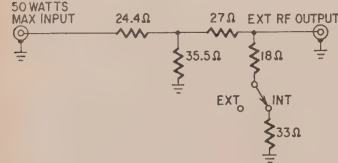


Fig. 5—The 511A Attenu-Load uses this circuit arrangement.

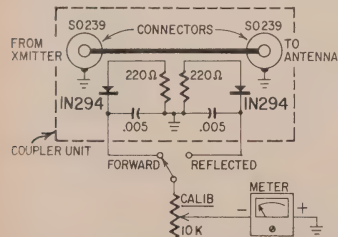
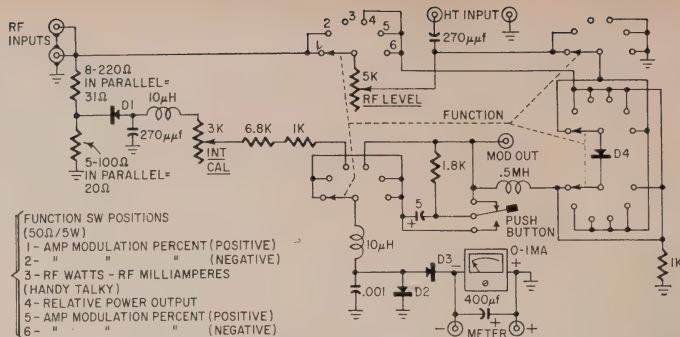


Fig. 6—Basic SWR setup as used in the 520 antenna tester.



Complete circuit of the model 510 CB transmitter tester.

low standing-wave ratio (SWR). (Standing waves are those that are reflected down the feed line.) SWR is calculated by the formula $\frac{V_r + V_f}{V_r - V_f}$

where: v_f = forward voltage and v_r = reflected voltage.

If there is no reflected voltage, the ratio is low—1 to 1. The larger number is usually read first. Thus, if the SWR is high, it would be read 5 to 1, 6 to 1, etc. On the 520, a GOOD-POOR scale is included for the nontechnical observer.

The 520 can be used with transmitters with up to 1,000 watts maximum output and may be left in the line as an output indicator. You can read the actual output of all transmitters from 0.5 to 1,000 watts in the frequency range of 3.5 to 180 mc.

Let's say the complaint is that a CB or other station can't be heard or is weak. Connect the 510 transmitter tester to the antenna connector of the transmitter. (A special adapter cable and two parallel inputs permit connection to just about any transmitter regardless of the type of coax connector used.) Turn on the transmitter. If the CB transmitter develops 1.5 to 2.5 watts, it has ample rf output. [Remember this is the actual rf output into a 50-ohm load and should not be confused with the 5 watts input (output plate voltage times current, designated by the FCC as maximum). Few transmitters have greater than 50% efficiency.]

If the rf output is low, you probably have a weak transmitting tube, defective crystal or component. Or perhaps the transmitter is improperly tuned or the input voltage is low.

If the π is normal, you are ready to make a modulation check. Switch to the proper position and calibrate the 510. Talk directly and distinctly into the mike at a distance of 1 to 2 inches, but do not shout. The meter should deflect upward to near 100%. (Some transmitter designs restrict modulation to around 75%.) If modulation is low, it should be corrected. A lack of "talk power" restricts the range as surely as low rf carrier power. Check for weak tubes, low voltages, defective mike, etc.

Whatever the trouble, you now know

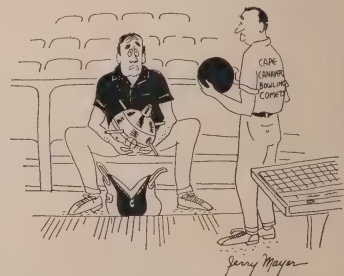
in what transmitter section to look.

The antenna tester will often spot antenna faults that cannot be detected any other way. On new installation always check and record the SWR. This not only spots possible antenna or lead-line defects in the installation, but is invaluable as a guide for antenna performance in subsequent service. Most commercial antennas have low SWR. So if a SWR is high, check for improper feed-line impedance, poor connections, etc. Corroded or loose connections that may not show up on an ohmmeter—even if it were possible to make the test—are immediately detected by the 520.

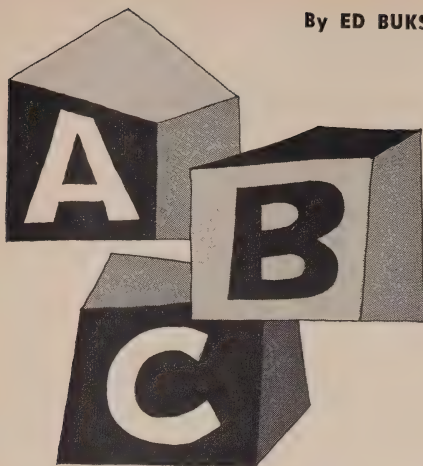
If you build your own antenna, you must know its efficiency—you may be losing half or more of your power in standing-wave reflections. Remember, adjustments at the transmitter end have no effect on SWR. Only a properly matched feed line and antenna can eliminate radiation losses from standing waves.

You can read the actual watts going into the feed line and antenna with the #20. The scale is calibrated 0-10. If you don't push any buttons, the scale must be multiplied by 100. In other words, you can read up to 1,000 watts forward power. Depressing the $\times 10$ or $\times 1$ buttons reduces the scale accordingly. Where SWR is high, you must subtract the reflected power from the forward power to arrive at the actual power going into the antenna.

The 520 may also be used on 72- to 75-ohm lines by simply subtracting 0.4 from the SWR scale. END



"Good grief! No wonder we didn't get a signal from that satellite we sent up today!"



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One-shot multivibrator: A type of multivibrator having only one stable state. The circuit is designed so that one side (tube or transistor) conducts and the other side is cut off. The circuit is not free-running and remains in this condition until triggered by an input pulse. Each input reverses the condition of the circuit, and the circuit returns to its initial condition after a length of time determined by component values, producing a "standardized" output pulse independent of the size and shape of the input trigger pulse. This makes the circuit useful in pulse-shaping applications. The one-shot multivibrator is also known as a *monostable multivibrator*, *delay multivibrator*, *univibrator* or *pulse equalizer*.

Open loop: A control system that does not use feedback for self-correction. The volume control of a radio receiver is part of an open-loop control system. This control can be used to adjust the volume level but does not provide any corrective action to maintain a constant volume level. The avc system, however, is part of a closed-loop system since it provides a corrective action (bias) to maintain a constant volume level.

Oscillograph recorder: Mechanical oscillograph in which a pen traces the waveform on a moving strip of paper. The pen is mechanically linked to a D'Arsonval movement so that changes of current flow cause the pen to deflect across the paper chart. A modification

of this pen-and-ink type of recorder employs a heated stylus to write on a chemically treated paper that becomes discolored where it contacts the heated stylus.

Although its frequency response is severely limited by the inertia of the mechanical components, the oscillograph recorder has the advantage (over conventional oscilloscopes) of producing a permanent record. Frequency response can be improved by using a beam of light as the writing element. The beam, reflected from a mirror galvanometer, writes on a strip of photographic film or paper. The chart is chemically developed to make the trace visible. The oscillograph recorder is also known as a strip-chart recorder.

Overshoot: The tendency of an automatic control system to overcorrect, causing the controlled quantity to pass through the desired value and to initiate an opposite correction (see Hunting).

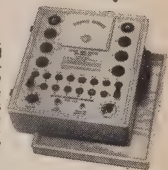
Peaking transformer: Transformer designed to saturate at relatively low values of primary current. As shown in Fig. 18, changes of primary current produce changes of magnetic flux only for small values of current flow, and the core is saturated during most of the input cycle. Since voltage is induced in the secondary only when the magnetic flux is changing, secondary voltage is zero during most of the input cycle. The peaking transformer is useful as a waveshaping device, changing a sine

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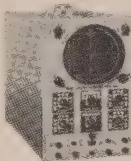
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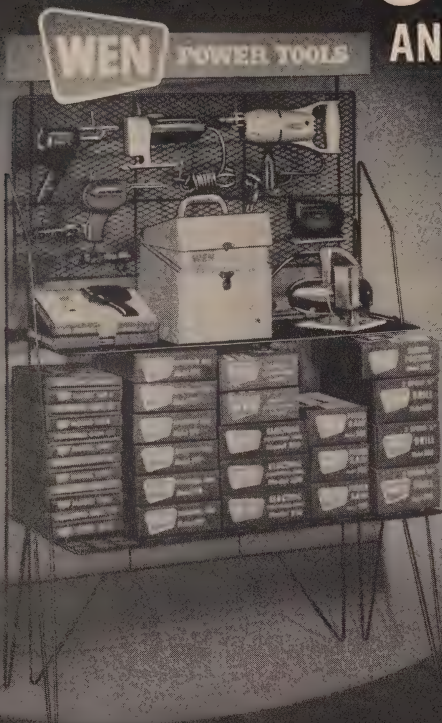
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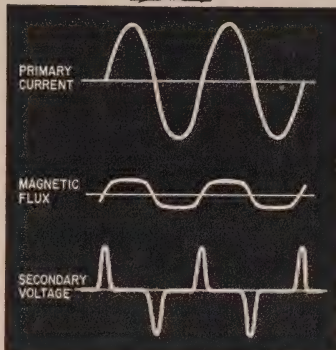


Fig. 18—Peaking transformer saturates at low value of primary current, converting sine wave input to pulse output.

wave input to a narrow pulse output.

Phanotron: Thermionic gas-filled diode.

Phase-controlled rectifier: Rectifier circuit using a thyatron as a rectifying element and a variable-phase sine wave for grid bias. As shown in Fig. 19, the sine wave applied to the grid lags behind the sine wave of plate voltage. As a result, grid voltage returns from its negative excursion during the positive half-cycle of plate voltage. As the grid voltage returns from its negative half-cycle, the bias decreases to the critical value (indicated by the control locus) and the thyatron ionizes. The thyatron now continues to conduct for the remainder of the positive alternation of plate voltage.

If the grid voltage is made to lag the plate voltage by an even greater angle, the grid returns from its negative alternation at a later time during the positive alternation of plate voltage. The thyatron now fires later in the cycle, reducing the conduction time per

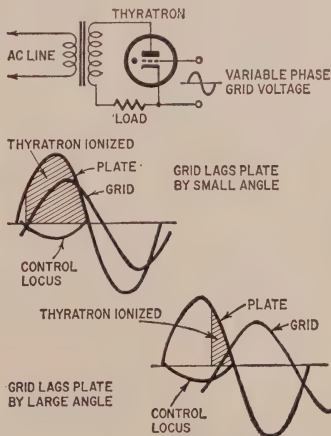


Fig. 19—Grid voltage of phase-controlled rectifier lags behind plate voltage. Angle of lag determines firing point of thyatron.



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cycle and the average current through the load. Load current can be varied from its maximum value down to zero simply by varying the phase of the grid voltage. Industrially, the phase-controlled rectifier is used for motor speed control and for delayed firing of ignitron welding circuits (see Back-to-back circuit).

Phase-shifting bridge: Bridge circuit used for varying the phase of the grid voltage in a phase-controlled rectifier. The bridge, shown in Fig. 20, consists of a series combination of resistance

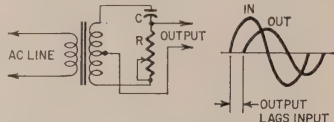


Fig. 20—Phase-shifting bridge produces sine wave output that lags behind input. Angle of lag can be adjusted with a variable resistance.

and capacitance connected across a center-tapped transformer. The sine-wave output of the bridge lags behind the sine-wave input by an angle determined by the values of R and C. The phase of the output voltage can be varied nearly over the entire range of 0° to 180° with the variable resistor. The same effect can be produced by

using inductance instead of capacitance in the phase-shifting bridge.

Photoconductive cell: Light-sensitive cell whose resistance decreases with an increase of illumination.

Photoelectric counter: Instrument used for counting objects on a conveyor belt, assembly line, etc. Each object to be counted passes through a light beam and momentarily blocks the illumination to a photo-relay. The relay contacts energize a register: an electromechanical counter consisting of a set of numbered discs like those used to indicate automobile mileage.

Photoelectric cutoff control: Photo-relay circuit used for cutting a long strip of paper, cloth, metal or other material into predetermined lengths or at predetermined positions. Package labels, for example, are printed on a long strip of paper which must then be cut into individual labels. A small *register mark* is printed on each label near the edge of the paper. These register marks are sensed by a phototube as the paper strip passes through the cutting machine. The phototube output is amplified and used to activate the cutting blade. The cutting blade is so positioned with respect to the phototube that it strikes the paper strip between one label and the next.

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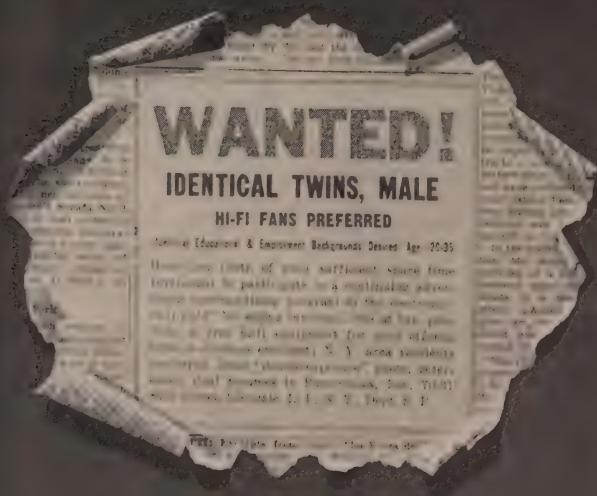
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Feb. 5th:

(Paco ran this ad in The New York Times)



Feb. 27th:

(the Taylor Twins began their duel of kits!)

*Don and Larry Taylor, with twin backgrounds and skills, have competitively built kit after kit, Paco vs. other makes. In one test Don built the Paco, in the next Larry did. Net results: Paco kits proved faster, easier, and better in performance. **For a typical Twin-Test report turn the page.***

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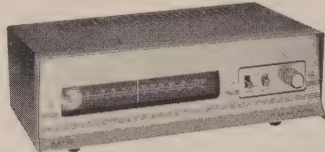


SA-40 STEREO PREAMP-AMPLIFIER: Power: 20W (RMS) per channel, 40W total. Peak, 40W with 80W total. Response: 30 cps to 90 Kc, within 1.0 DB. Distortion: within 0.5% at 20W per channel. Includes: 14 inputs and 14 Panel Controls, black and gold case.

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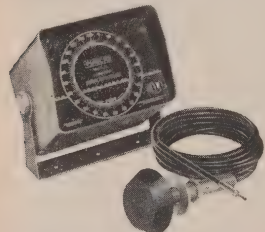
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"I built a competing Stereo Preamp Amplifier."

Don Taylor, 39 Cross Street, Smithtown, N. Y. "Neither Larry nor I are speed demons because we're very meticulous about wiring and soldering. So I was even more surprised when it took me 50% more time to finish my kit. My problem began when I tried to separate the parts. The resistors were in boxes, but not in any logical way: identical resistors often wound up in different boxes. The instruction book was clumsy to work from. It caused wasteful mistakes. Once I lost 20 to 25 minutes because I misread a tiny key letter that meant not to solder a certain connection. A lot of the fun of kit-building was lost when I had to spend time making up for shortcomings of the packaging and the instruction manual."



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Wilmar Distributors Corp.*
Zalytron Tube Corp.

Poughkeepsie Greylock Electronics†
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(Continued on next page)

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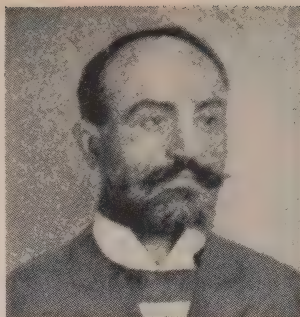
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INVENTORS OF RADIO

Augusto Righi

By DEXTER S. BARTLETT

AUGUSTO RIGHI WAS A BRILLIANT ITALIAN basic physicist and educator who sought facts for the sake of science rather than publicity. This has resulted in his being an unknown in this missile age. Both myself and others have diligently sought information on Righi but, with the exception of short biographies, very little information can be found in English. Yet, as a research scientist and educator, he laid much of the foundation for today's electronics as well as other physical sciences. As Guglielmo Marconi was a student at Bologna, while Righi was professor, they became acquainted and Righi was a great help to Marconi, both in encouragement and actual experimentation.

Augusto Righi (sometimes spelled Richi or Rigi) was born in Bologna, Italy, on Aug. 27, 1850. He attended the Bologna University, where he received his diploma. In 1873, he became professor at the Bologna Technical Institute, later to become principal extraordinary at Palermo University where he taught up to the time of his death in 1920. He received many honors and several medals from universities in Italy and elsewhere. In 1872, he was natural science ambassador to the King of Italy. In Rome, he published the results of his theoretical experiments, in 250 scientific papers, embracing almost all subjects in the realm of the physical.

Besides his basic researches in electromagnetic waves, he made two practical contributions to wireless with his oscillator and detector, the basic equipment used in Marconi's first experiments. It was remarked by a veteran engineer that "before describing methods Marconi devised by which he realized his ambition, it is advisable to refer to the work of those pioneers who influenced Marconi in his early experiments, and of whose work he had knowledge: Maxwell, Hertz, Righi and Branly."

One disadvantage of Hertz' radiator lay in the fact that the sparks in a short time oxidized the little knobs and roughened their surfaces, resulting in irregular action. Professor Righi overcame this difficulty by partly enclosing two metal spheres, A and B in the sketch, in an oil-tight case, the inner

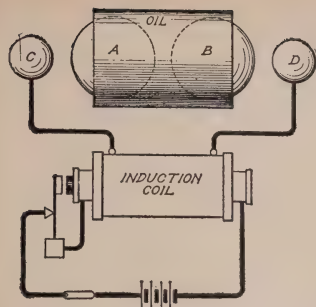
hemispheres being immersed in petroleum with only a minute gap between them. In a line with these spheres are ranged two smaller spheres, C and D. It is between A and B in the oil gap that the oscillatory spark takes place, the other two sparks serving merely to charge the large spheres. This arrangement not only produced a more constant spark by preventing pitting electrodes but greatly extended the range of wavelengths which it was possible to employ in investigations of this character. The dimensions of the oscillator could thereby be reduced and the amplitude of the oscillations increased greatly as higher potentials could be reached before the energy was released by discharge. Righi obtained oscillations at 12 kmc by using 8-millimeter spheres for A and B.

He contributed a new "detector" by cutting thin lines on the back of a mirror, dividing the metallic surface with a diamond point into narrow unconnected strips. This provided a spark distance much finer than could be attained by a micrometer gap, as used by Hertz, hence affording greater sensitivity and greatly increasing the distance. Hertz covered only a few meters. The frog's leg, to which we owe the discovery of electric current, had been previously tried by others but had given even poorer results as a detector.

It is a strange coincidence that it took at least 50 years for the electronic industry to go back to centimeter waves. Later researchers added antenna and ground to their oscillators, lowering their frequencies greatly and therefore lengthening the wavelengths.

In his youth, Righi did a great deal of research in the basic relationships between mechanical, electrical and magnetic forces, endeavoring to prove them all of one origin. In this he failed but, considering the status of atomic physics nearly a century ago, this was understandable. However, he did accomplish much in extending Faraday's research on electric and magnetic forces.

Righi did extensive research on the Kerr cell, which is now used in some facsimile systems, and discovered the rotation of the polarization plane with different light frequencies. This in turn led him to the discovery of the photoelectric effect of various materials and then on to work on ionized gases.



Righi's oscillator.

From 1915 to his death, he devoted his researches to the theory of relativity, being one of the few physicists of that day who could understand Einstein's mathematics.

His principal scientific papers were: "The Optics of Electric Oscillations," 1897; "The Motion of Ions in the Electric Discharge," 1903; "Telegraphy without Wires" (in collaboration with B. Dessau), 1903; "The Modern Theory of Physical Phenomena," 1904; "On the Hypothesis of the Electrical Nature of Matter," 1907; "New Views of the Intimate Structure of Matter," 1910; "Radiating Matter and Magnetic Rays," 1910; "The New Physics," 1911; "Ionomagnetic Rotation," 1915; "Electro-Atomic Phenomena under the Action of Magnetism," 1918. END

References:

Enciclopedia Italiana, 1936
Cyclopedia of Applied Electricity, 1911
Florian Cajori, History of Physics

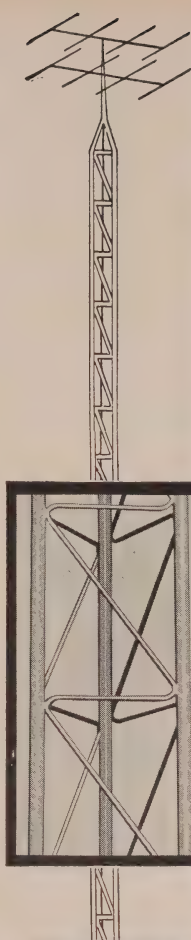
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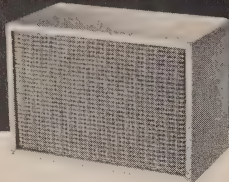
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A Current Problem

Both meters read the same current. This is an example of the *reciprocity theorem*, which states:

If an emf of any character located at one point in a linear network produces a current at any other point in the network, the same emf acting at the second point will produce the same current at the first point.

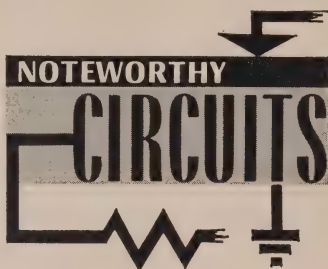
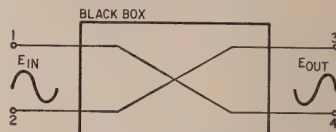
Impossible Voltages

The 30- μ f electrolytic capacitor, connected between the arm of the vertical linearity control and chassis, was completely open. This evidently allowed the vertical oscillator and output stage

to go into some kind of wild oscillation, at or near the horizontal frequency (it was never exactly traced out) which accounted for the appearance of the high negative voltage at the plate of the output half of the 12BH7.

Black Box Brain Twister

The wires are crossed, from terminal 1 to 4 and from 2 to 3.



CRYSTAL DIODE MODULATOR

This crystal-diode modulator enables you to modulate any rf signal up to 1,000 mc with a signal up to 5 mc. Thus, you can modulate a vhf or uhf rf signal generator with a video signal tapped off a TV receiver.

In this circuit, the modulating element is a 1N21-B point-contact crystal diode connected between the rf input and output terminals. The signal is modulated by superimposing the modulating voltage on the diode's dc bias. The modulating voltage must be much larger than the rf signal. The modulating voltage varies the diodes and thus produces an amplitude-modulated output wave.

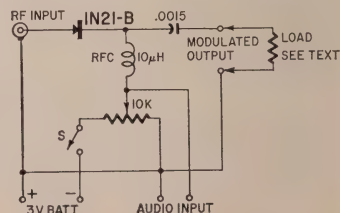
The resistance of the output load resistor is determined by the input impedance of the device connected to the output terminals. Use 300 ohms for TV receivers and as high as 1,000 ohms for ordinary radios. The values of the rf choke and capacitor depend on the frequency of the rf signal. I use the values shown on the diagram.

It is a good idea to check the diode modulator on a set that is operating perfectly before using it when aligning a defective set. Listen to the signal on the receiver and set the bias control and adjust the modulating voltage for

optimum performance. Record the settings for future reference. You can use a scope to check the modulation pattern at the modulator output. Details on this setup are in most radio and scope handbooks.

The construction of the diode modulator is shown in the photographs. The metal case is 2 3/4 x 2 x 1 1/2 inches. Rf is fed in through a single-conductor mike connector and the modulating signal is fed in through the terminals on top. Modulated rf comes out the terminals on the other end.

The 1N21-B is a high-frequency point-contact diode. It'll probably come in a lead wrapper or container. The large end fits in a clip from a cartridge type fuse holder. A terminal from an old

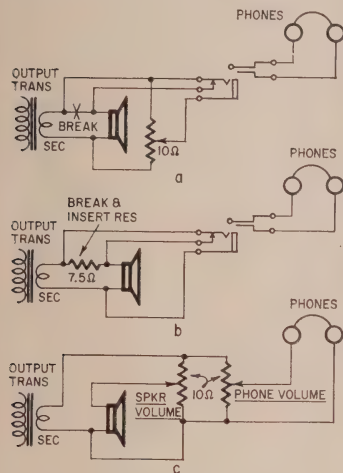


octal socket fits over the other end. When mounting the crystal, ground one hand to the chassis. Otherwise, the diode may be destroyed by a static discharge from your body.—James A. Fred

CLOSE-UP TV LISTENING

One family discovered, to their horror, that when the earphone attachment was in use, the TV's speaker was silent. The attachment—a present for a hard-of-hearing grandmother—used a circuit that opened the speaker's voice-coil circuit. See circuit *a* in the illustration.

A 7.5-ohm fusible resistor that I carried in the tube caddy saved the day. It restored speaker volume when connected as at *b*. Circuit *c* is an improvement that allows independent control



of speaker and earphone volume.—E. C. Carlson

END

50 Years Ago

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Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Practical Electrics	1921
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In December, 1911, Modern Electrics

The Fessenden Interference Preventer, by Eberhardt Rehtin.

Selenium and Its Extraordinary Characteristics, by Charles Proner.

Using Telephone Receivers Without Detectors.

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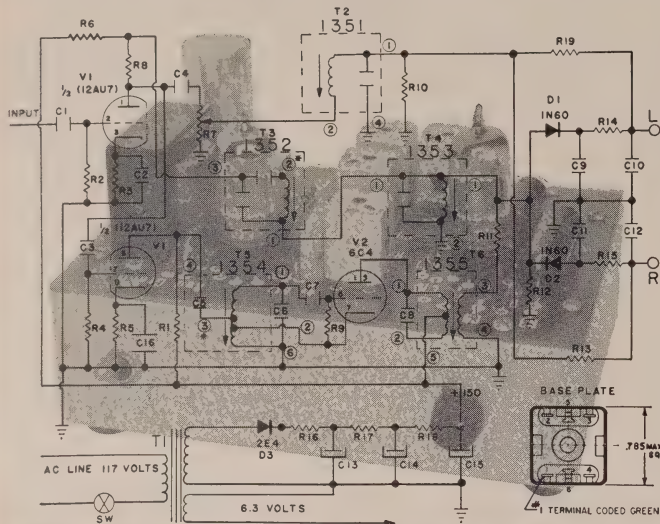
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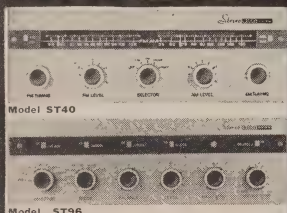


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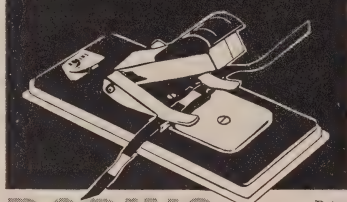
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TUBES ARE OUTNUMBERED THIS MONTH by a wealth of interesting semiconductors. There's a reflex amplifier, uhf units with a maximum frequency of 1,110 mc and some high-speed switching transistors. On the tube side you'll find a group of horizontal deflection amplifiers in Novar envelopes.

2N1405, 2N1406, 2N1407

A group of uhf p-n-p transistors made by gaseous diffusion. They are intended for reliable operation in rf applications in the vhf-uhf ranges. Maximum frequencies for these units are 1,100 mc—2N1405; 750 mc—2N1406, and 650 mc—2N1407.



2N1405, 6, 7

Maximum ratings for these Texas Instruments transistors at 25°C are:

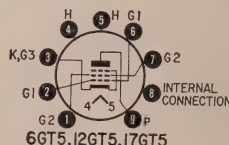
V_{CB}	30
V_{EC}	20
V_{EB}	1
I_C (ma)	50
P_{Total} (mw)	75

Electrical characteristics are:

2N1405	-06	-07
h_{fe} ($V_{CE} = -6$, $I_C = 2$ ma, $f = 100$ mc)	10	7.5
NF ($V_{CE} = -6$, $I_C = 2$ ma, $f = 200$ mc, $R_s = 75$ ohms)	5 db	7 db

6GT5, 12GT5, 17GT5

These RCA high-perveance single-ended beam power tubes in a Novar envelope are designed for use as horizontal deflection amplifiers in TV receivers. Except for heater ratings, the tubes are identical electrically. The 6GT5 heater is rated at 6.3 volts 1.2 amperes; the 12GT5, 12.6 volts at 600 ma; the 17GT5, 16.8 volts at 450 ma. The 12GT5 and 17GT5 have a controlled warmup time of 11 seconds.



Maximum ratings in horizontal deflection amplifier service:

V_p (boost plus dc power supply)	770
(peak positive pulse)	6,500
(peak negative pulse)	1,500
I_k (peak ma)	550
(average ma)	175
$G2$ (input watts)	3.5
P_p (watts)	17.5

2N1864

A hermetically sealed p-n-p germanium micro alloy diffused-base transistor designed for use as a reflex amplifier in broadcast receivers. It provides high gain at both audio and 455-kc frequencies, eliminating the need for



an additional audio frequency amplifier in portable radios.

Maximum ratings of the Philco 2N1864 are:

V_{CB}	20
V_{CES}	20
V_{EB}	0.5
I_c (ma)	50
P_{total} (mw)	60

2N706, -A, -B

A series of n-p-n silicon Planar transistors designed for high-speed switching and high-frequency amplifier service. The transistors are useful in nanosecond switching circuits and hf and vhf tuned amplifiers.



Maximum ratings of these General Instrument semiconductors are:

2N706 -706-B -706-A

V_{CBO}	25	25	25
V_{CEO}	3	5	5
V_{CER} (10-ohm resistor from base to emitter)	20	20	20
P_{total} (mw)	300	300	300

2N511, -A, -B

This group of p-n-p alloy-junction germanium transistors is designed for high-power applications. With their 10-watt dissipation, they are especially useful in high-power conversion, high-current switching and audio amplifier output stages.

Maximum ratings for these Texas Instruments transistors at 25°C are:

I_c (amps)	25
I_b (amps)	5
P_{total} (watts)	150

Maximum voltage ratings are not specified because exceeding breakdown voltages will not permanently damage

(Continued on page 106)

STEREO SYSTEM FOR A MILLION-AIRE: 4 SELECTIONS

Gentlemen's Quarterly magazine asked James Lyons, editor of *The American Record Guide* (the oldest record review magazine in the United States), to poll hi-fi authorities on which audio components they would choose for the best possible stereo system, without any regard for price.

Three writers in the audio field and one audio consultant made up independent lists. The ideal systems they projected in the April, 1960 issue of *Gentlemen's Quarterly* are suitable for discriminating millionaires—one of the systems, using a professional tape machine, would cost about \$4000.

ACOUSTIC RESEARCH AR-3

loudspeakers are included in three of the lists,* and these are moderate in price. (There are many speaker systems that currently sell for more than three times the AR-3's \$216.) AR speakers were chosen entirely on account of their musically natural quality.

Literature on Acoustic Research speaker systems is available for the asking.

*In two cases alternates are also listed. For the complete component lists see the April, 1960 *Gentlemen's Quarterly*, or write us.

ACOUSTIC RESEARCH, INC. 24 Thorndike Street Cambridge 41, Massachusetts



Duotone needles, of course... tipped with genuine diamonds, sapphires or osmium. Most people forget to change their styli or don't know how to change them. Why not suggest a Duotone diamond needle replacement for every phonograph that comes into your shop? It's the stylus with the whole diamond tip that's handset and hand polished. Your customers will appreciate the service and you'll appreciate the increase in business.

Write for Free 1961 Duotone Needle Wall Chart and see DUOTONE Distributor.

DUOTONE
COMPANY, INC. KEYPORT, N. J.

Something every
TAPE RECORDER OWNER
would like for Christmas

SWITCHCRAFT®
"Mini-Mix"



from
\$7.95
MIXES 2
SOUND SOURCES
(1) Voice with record or radio, (2) 2 Mics in different places, (3) Instrument with background music. No technical knowledge necessary.

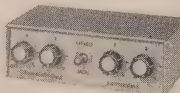
Built-in volume control for each sound source. Ask for free reference guide No. 236 to select proper "Mini-Mix."

4 CHANNEL MIXERS

Add to the enjoyment and versatility of Recorders. User can blend or fade out signals for professional type recordings.

Monophonic type permits mixing up to 4 sound sources from TV, Radio, Phonograph or Microphones to one input of Recorder. Stereo type provides for Stereo music accompaniment to narration of home movies, etc.

See your Hi-Fi specialist or write for name of dealer nearest you.



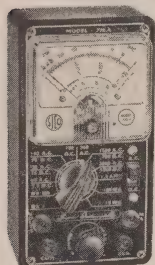
SWITCHCRAFT® 5589 N. Elston Ave.
Chicago 30, Ill.

EXAMINE ANY OF THESE TESTERS BEFORE YOU BUY!!

Yes, we offer to ship at our risk one or more of the testers described on these pages.

SUPERIOR'S NEW MODEL 770-A

VOLT-OHM MILLIAMMETER



FEATURES:

- Compact—measures $3\frac{1}{2}'' \times 5\frac{1}{2}'' \times 2\frac{1}{2}''$.
- Uses "Full View" 2% accurate 850 Microampere D'Arsonval type meter
- Housed in round-corned, molded case.

SPECIFICATIONS:

- 6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts.
- 6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts.
- 2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm.
- 3 D.C. CURRENT RANGES: 0-15/150 Ma., 0-1.5 Amps.
- 3 DECIBEL RANGES: -6 db to +18 db, +14 db to +38 db, +34 db to +58 db.

The Model 770-A comes complete with test leads and operating instructions. Price is \$15.85. Terms: \$3.85 after 10 day trial then \$4.00 monthly for 3 months.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL VIEW METER

Compare it to any peak-to-peak V.T.V.M. made by any other manufacturer at any price!

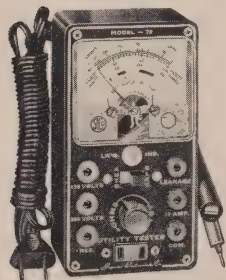


SPECIFICATIONS:

- DC VOLTS—0 to 3/15/75/150/300/750/1500 volts at 11 megohms input resistance.
- AC VOLTS (RMS)—0 to 3/15/75/150/300/750/1500 volts.
- AC VOLTS (Peak to Peak)—0 to 8/40/200/400/800/2000 volts.
- ELECTRONIC OHMMETER—0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
- DECIBELS—10 db to +18 db, +10 db to +38 db, +30 db to +58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v).
- ZERO CENTER METER—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads and carrying case. Price is \$42.50. Terms: \$12.50 after 10 day trial then \$6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 70 UTILITY TESTER



INCLUDED FREE

64 page condensed course in electricity. Profusely illustrated. Written in simple, easy-to-understand style.

FOR REPAIRING ALL ELECTRICAL APPLIANCES MOTORS ★ AUTOMOBILES

As an electrical trouble shooter the Model 70:

- Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc.
- Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc.
- Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc.
- Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).

As an Automotive Tester the Model 70 will test:

- Both 6 Volt and 12 Volt Storage Batteries
- Generators
- Starters
- Distributors
- Ignition Coils
- Regulators
- Relays
- Circuit Breakers
- Cigarette Lighters
- Stop Lights
- Condensers
- Coils
- Directional Signal Systems
- All Lamps and Bubs
- Fuses
- Heating Systems
- Horns
- Also will locate poor grounds, breaks in wiring, poor connections, etc.

Model 70 comes complete with 64 page book and test leads. Price is \$15.85. Terms: \$3.85 after 10 day trial then \$4.00 monthly for 3 months.

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL VIEW METER



SPECIFICATIONS:

- D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
- A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
- D.C. CURRENT: 0 to 1.5/15/150 Ma.
- 0 to 1.5/15/150 Amps.
- RESISTANCE: 0 to 1,000/100,000 Ohms.
- 0 to 10 Megohms.
- CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd.
- REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
- INDUCTANCE: .15 to 7 Henries.
- 7 to 7,000 Henries.
- DECIBELS: -6 to +18, +14 to +38, +34 to +58.

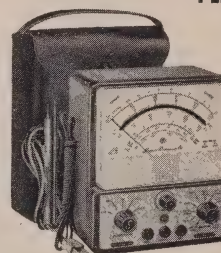
The following components are all tested for **QUALITY** at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. All Germanium Diodes.
All Silicon Rectifiers. All Silicon Diodes.

Model 79 comes complete with operating instructions, test leads and carrying case. Price is \$38.50. Terms: \$8.50 after 10 day trial then \$6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER



6 INCH FULL-VIEW METER provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.

MIRRORED SCALE permits fine accurate measurements where fractional readings are important.

SPECIFICATIONS:

- 7 D.C. VOLTAGE RANGES: (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500 Volts.
- 6 A.C. VOLTAGE RANGES: (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75/150/300/750/1500 Volts.
- 3 RESISTANCE RANGES: 0 to 2,000/200,000 Ohms. 0-20 Megohms.
- 2 CAPACITY RANGES: .00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.
- 5 D.C. CURRENT RANGES: 0-75 Microamperes, 0 to 7.5/75/750 Milli-amperes, 0 to 15 Amperes.
- 3 DECIBEL RANGES: -6 db to +18 db, +14 db to +38 db, +34 db to +58 db.

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Price is \$42.50. Terms: \$12.50 after 10 day trial then \$6.00 monthly for 5 months.

DID YOU EVER?

- ▶ Order merchandise by mail, including deposit or payment in full, then wait and write...wait and write?
- ▶ Purchase anything on time and sign a lengthy complex contract written in small difficult-to-read type?
- ▶ Purchase an item by mail or in a retail store then experience frustrating delay and red tape when you applied for a refund?

Obviously prompt shipment and attention to orders is an essential requirement in our business... We ship at our risk!

NO

CONTRACT TO SIGN

CO-MAKERS

**EMPLOYER
NOTIFICATION**

The simple order authorization included in this offer is all you sign. We ask only that you promise to pay for or return the goods we ship in good faith.

**EXAMINE ANY ITEM YOU SELECT
IN THE PRIVACY OF YOUR OWN HOME**

Then if completely satisfied pay on the interest-free terms plainly specified. When we say interest-free we mean not one penny added for "interest" for "finance" for "credit-checking" or for "carrying charges." The net price of each tester is plainly marked in our ads—that is all you pay except for parcel post or other transportation charges we may prepay.

**SUPERIOR'S NEW MODEL 82A
MULTI-SOCKET TYPE**

TUBE TESTER

SPECIFICATIONS:

- Tests over 1000 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82A comes housed in handsome, portable case.
Price is \$36.50. Terms: \$6.50 after 10 day trial then \$6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 83A

C.R.T. TESTER

Tests and Rejuvenates

ALL PICTURE TUBES



ALL BLACK AND WHITE TUBES
From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES
Test All picture tubes—in the carton—out of the carton—in the set!

Model 83A provides separate filament operating voltages for the older 6.3 types and the newer 5.4 types.

Model 83A properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

Model 83A will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus.

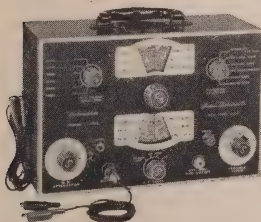
Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83A applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83-A comes housed in handsome portable Saddle-stitched Texon case—complete with socket for all black and white tubes and all color tubes. Price is \$38.50. Terms: \$8.50 after 10 day trial then \$6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!



- ✓ R.F. Signal Generator for A.M.
- ✓ R.F. Signal Generator for F.M.
- ✓ Audio Frequency Generator
- ✓ Bar Generator
- ✓ Cross Hatch Generator
- ✓ Color Dot Pattern Generator
- ✓ Marker Generator

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers
• Black and White TV • Color TV

The Model TV-50A comes absolutely complete with shielded leads and operating instructions. Price is \$47.50. Terms: \$11.50 after 10 day trial then \$6.00 monthly for 6 months.

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL

TUBE TESTER



- Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the operator can instantly identify which element is under test.
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.
- **NOISE TEST:** Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

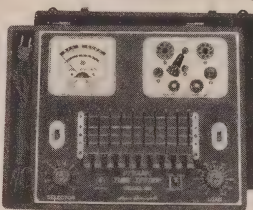
SEPARATE SCALE FOR LOW-CURRENT TUBES: Previously, on emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 comes housed in a handsome, portable, saddle-stitched Texon case. Price is \$47.50. Terms: \$11.50 after 10 day trial then \$6.00 monthly for 6 months.

SUPERIOR'S NEW MODEL 85

TRANS-CONDUCTANCE TYPE

TUBE TESTER



- Employs latest improved **TRANS-CONDUCTANCE** circuit. Test tubes under "dynamic" (simulated) operating conditions. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured as a function of tube quality. This provides the most suitable method of simulating the manner in which tubes actually operate in radio, TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.

• **SYMBOL REFERENCES:** Model 85 employs time-saving symbols (+, -, •, ▲, ▼) in place of difficult-to-remember letters previously used. Repeated studies proved to us that use of these symbols was actually easier.

scientifically selected symbols speeded up manufacturers increase the release of new tube types, this time-saving feature becomes necessary and advantageous.

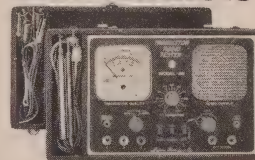
• **"FREE-POINT" LEVER TYPE ELEMENT SWITCH ASSEMBLY** marked according to RETMA basing, permits application of test voltages to any of the elements of a tube.

• **FREE FIVE (5) YEAR CHART DATA SERVICE.** Revised up-to-date subsequent charts will be mailed to all Model 85 purchasers at no charge for a period of five years after date of purchase.

Model 85 comes complete, housed in a handsome portable cabinet with slip-on cover. Price is \$52.50. Terms: \$12.50 after 10 day trial then \$6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 88

TESTS ALL TRANSISTORS AND TRANSISTOR RADIOS



AS A TRANSISTOR RADIO

TESTER
An R.F. signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble is located and pinpointed.

AS A TRANSISTOR TESTER

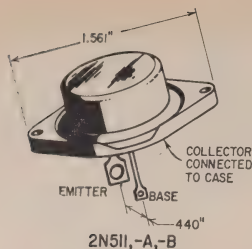
The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsenide types, without need for characteristic data sheets. The time-saving advantage of this technique is self-evident. A further benefit of this service is that it will enable you to test new transistors as they are released!

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-on Cables for Transistor Testing; an R.F. Diode Probe for R.F. & I.F. Tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete—nothing else to buy! Price is \$38.50. Terms: \$8.50 after 10 day trial then \$6.00 monthly for 5 months.

SEND POSTCARD TODAY (NO POSTAGE NECESSARY)

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC, INC., DEPT D-915 3849 TENTH AVENUE, NEW YORK 34, N.Y.



2N511, -A, -B

(Continued from page 101)
transistor characteristics if other maximum ratings are not exceeded.

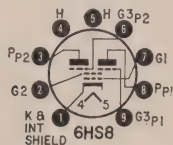
Electrical characteristics at 25°C:

2N511 -11-A -11-B

BV_{CBO} ($I_C = 5 \text{ ma}$, $I_E = 0$)	40	60	80
BV_{CEO} ($I_C = 500 \text{ ma}$, $I_E = 0$)	30	40	45
BV_{CES} ($I_C = 300 \text{ ma}$, $V_{BE} = 0$)	50	60	65
BV_{EBO} ($I_E = 5 \text{ ma}$, $I_C = 0$)	30	30	30

6HS8

A sharp-cutoff twin pentode of the 9-pin miniature type having a common cathode, grid No. 1 and grid No. 2. In addition G1 and G3 have separate pin connections so either can be used independently as a control electrode. The 6HS8 is designed for use in age amplifier, sync, and noise-limiting circuits of TV receivers. In such circuits,



one pentode performs the function of combined sync separator and sync clipper. The other unit serves as an age amplifier.

Characteristics of the RCA 6HS8 as a class A1 amplifier with both units operating are:

V_F (each unit)	100	100
V_{G2} (each unit)	-10	0
V_{G1}	67.5	67.5
V_{G1} adjusted for I_{G1}	100	100
I_P (Each unit) (ma)	—	2
I_{G2} (ma)	7	4.4
I_{K1} (ma)	7.1	8.5

2N960, -61, -62, -64, -65, -66

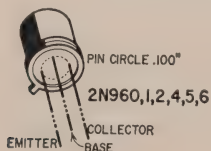
A string of p-n-p epitaxial switching transistors designed by Motorola for ultra-high-speed applications.

Maximum ratings are:

2N290	-61	-62	-64	-65	-66
V_{CE}	15	12	12	15	12
V_{CE}	15	12	12	15	12
V_{EE}	2.5	2	1	2.5	2

P_{total} (mw) 300 300 300 300 300 300
Electrical characteristics at 25°C:

h_{FE} ($I_C = -10 \text{ ma}$, $V_{CE} = 1 \text{ v}$)	55	55	55	95	95	95
(typical)	55	55	55	95	95	95
t_{on} (nsecs)	35	35	35	35	35	35
t_{off}	60	60	80	80	60	60

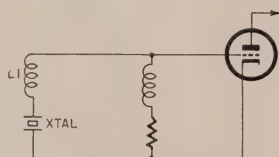


2N960, 1, 2, 4, 5, 6

USING DEFECTIVE CRYSTALS

Many experimenters and amateurs have either thrown away or stored in the junkbox defective quartz crystals. Very few take advantage of the fact that crystals can usually be made to oscillate by introducing a small amount of regeneration.

If the crystal is merely inactive, it will probably work by using this scheme. If the crystal is cracked, the



fracture should be carefully broken through and its edges flattened. Then round the corners on a fine carborundum stone. Be careful when using the carborundum stone to avoid scratching the crystal surface.

Experiments with dozens of crystals have shown that the final shape and size is unimportant. It is possible to get several good crystals from an inch-square plate in this manner, although not all crystals will oscillate on the original frequency.

For 80-meter crystals, coil L1 in the diagram may be 5 to 30 turns of No. 20 wire on a 1½-inch-diameter form. About half the number of turns is right for 40-meter crystals.—Alvin G. Sydnor

IMPROVING RECEIVER AND AMPLIFIER PERFORMANCE

Many amplifiers and radio receivers more than a year old can be improved by tightening grounds and other connections on the chassis.

In nearly every amplifier and receiver, dozens of bypass capacitors and resistors are grounded to the chassis by lugs and nut-and-bolt connections. The connections between the lug and chassis become oxidized in time, increasing the resistance of the connection. In effect, this places resistors in the circuit where they do not belong.

While the effect of such an added resistor in series with a resistor would ordinarily be negligible, it is another matter in the case of a capacitor. The cumulative effect of many such resistors in series with a similar number of capacitors will result in lowered sen-

sitivity, instability, alignment shift and other faults.

This effect can usually be eliminated completely by tightening all screws from the top of the chassis. Even when screws are already tight, the slight movement will erase oxidation.—Warren J. Smith

HANDY TOOL

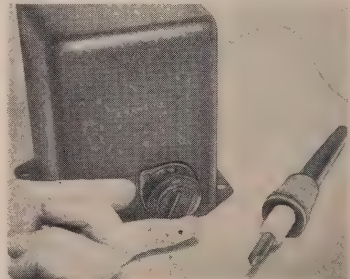
A useful shop aid for extracting dust or small components from cramped locations is a piece of soft copper tubing poked through a snug-fitting hole in a wood spool. Grind the outside of the spool down to make a tight fit in the



nozzle end of the hose on a vacuum cleaner. It's also useful for picking up stray bits of solder or other metal parts that have lodged in or around circuitry and components.—Harry J. Miller

SOLDERING IRON ON STANDBY

Those who have to let a hot soldering iron or pencil stand idle on the bench for considerable periods of time should put this trick to work. Plug the iron



into a variable isolation transformer such as the Stancor IS-100 shown. The transformer's variable output lets the iron stand idle at low heat, and lets you quickly boost it back to full heat the moment it's needed. This reduces tip oxidation and frequent cleaning and tinning.—John A. Comstock END

New Sylvania Technique eliminates erratic pin soldering

Picture tube callbacks due to "open-pin connections" dramatically reduced



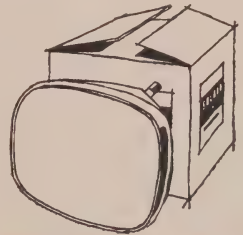
The "old" conventional pin soldering method relied upon contact between pin and wire only at their tips.



New Sylvania pin soldering technique extends solder far up into the pins—provides maximum contact with the wire—assures low electrical resistance and high mechanical strength.

What does the new Sylvania pin soldering technique mean to you? It means the solution of a long-standing, industry-wide pin soldering problem. Callbacks will be reduced—crimping and resoldering will be a thing of the past.

Thousands of service technicians have proven for themselves—in millions of service calls—that Sylvania SILVER SCREEN 85 TV PICTURE TUBES are the surest way to build a better business. You should, too. Electronic Tubes Division, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.



SYLVANIA

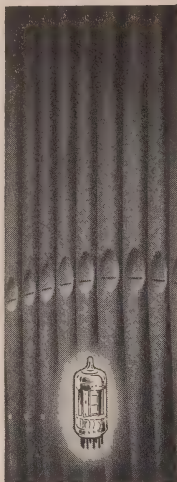
SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS



Schober

captures
magnificent
pipe organ
tone
in a
tiny
electronic
tube.

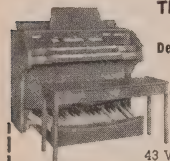


Here is magnificent Pipe Organ tone; tremendous tonal color range; two 61-note pipe-organ keyboards; hand-rubbed cabinetry in the finish of your choice. Taken together they comprise a superlative electronic instrument comparable to organs selling for \$2,500 to \$6,000.

Yet, when you assemble the Schober of your choice, you save more than half the normal cost and create a superb instrument to bring the delightful gift of music to your family.

Work requiring knowledge and experience is eliminated. All that remains is the pride and pleasure of watching a fine musical instrument take shape under your own hands. The Schober organ you assemble will equal or surpass any factory-built organ for quality, reliability and circuitry.

The coupon brings you full details on how you can start building the Schober of your choice with an investment of as little as \$18.95. In addition, you may have an exciting 10" LP record demonstrating Schober's full range of tones and voices. The \$2 charge for the record is refunded when you order your starting kit. No salesman will call.



THE SCHOBOR ORGAN CORPORATION
Dept. RE-16, 43 West 61st St.
New York 23, N. Y.

THE SCHOBOR ORGAN CORP.
Dept. RE-16,

43 West 61 St., N.Y. 23, N.Y.

☐ Please send me FREE full-color booklet and other literature on the Schober organ.

☐ Please send me the Hi-Fi demonstration record. I enclose \$2 which is refundable when I order my first kit.

name _____

address _____

city _____ zone _____ state _____

NEW PRODUCTS

TUBE TESTER for all new tube types, all TV and radio tubes. Model 648S (illus) has 23 separate heater voltages from 0.75 to 117. Uses quick variable-sensitivity short test up to 2



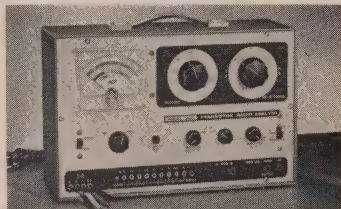
megohms. Model 658A for industrial, lab and engineering applications makes heater continuity, heater current, rectifier, Dynamic "Eye" tube and grid-leakage tests on old and new tube types.—Jackson Electrical Instrument Co., 124 McDonough St., Dayton, Ohio.

TV SWEEP CIRCUIT ANALYZER, model S117. Uses signal injection plus direct component substitution for testing circuits with set turned on. Checks horizontal oscillator, output, deflection yoke, output transformer, and vertical deflection



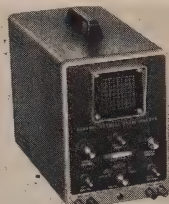
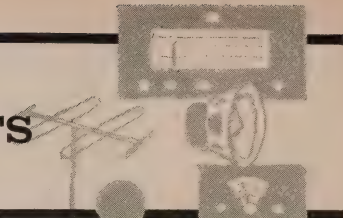
yoke and second anode voltage. External circuit measurements 0-300 and 0-1,000 volts dc for checking B-plus and boost volts; 0-300 and 0-1,000 volts peak to peak for checking sync and oscillator outputs, 0-300 ma dc for checking current through B-plus fuse.—Sencore Inc., 426 Westgate Drive, Addison, Ill.

TRANSISTOR RADIO ANALYST, model 960. Includes sig gen, power supply, vtm, milliammeter, in- and out-of-circuit transistor tester. Supplies modulated audio and unmodulated



signals. Separate low-impedance audio output for signal injection into speaker voice coils. 117 volts, 50-60 cycles ac.—BAK Mfg. Co., 1801 W. Belle Plaine, Chicago, Ill.

3" OSCILLOSCOPE. Kit model 10-21. Identical vertical and horizontal amplifiers, frequency response ± 2 db from 2 cycles to 200 kc, sensitivity 0.25 volt rms/inch peak-to-peak deflection at 1 kc with input impedance 10 meg shunted by 20 μ f. Sweep gen 20 to 100,000 cycles in 4 ranges with automatic sync and retrace blanking. 3RP1 C-R tube with neck shield to minimize effects of extraneous field. Focus and



astigmatism controls for sharp trace; power supply fused for protection.—Heath Co., Benton Harbor, Mich.

TUBE TESTER, model 1100. Checks all tubes including novistors, Compactrons, Novars, 10-pin types; also battery tubes, auto radio hybrids, voltage regulators, foreign, hi-fi, thyatrons and



industrial tubes. Tests for dynamic cathode emission, shorts and leakage, grid leakage and gas content.—Mercury Electronics Corp., 111 Roosevelt Ave., Mineola, N. Y.

IN-CIRCUIT CAPACITOR TESTER, model 1C-60. Isolates troubles due to faulty capacitors without disconnecting them. Clear readings on indicator for all open or shorted capacitors, including



electrolytics. Open test provides open-circuit test for capacitors low as 5 μ f; short test shows shorted capacitors with circuit shunting resistance as low as 10 ohms.—Precision Apparatus Co., Inc., 70-31 84th St., Glendale 27, N. Y.

CAP-POT POTENTIOMETER, series 60M. Electrical element in knob, which also serves as moisture- and dustproof housing. Terminals sealed, brought out through rear of mounting

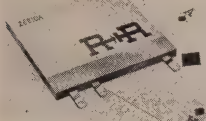


bushing. Resistance range 10 to 10,000 ohms, wirewound, rated $\frac{1}{4}$ watt at 40°C. Linear taper. Resistance tolerance 10%.—ClaroStat Mfg. Co., Inc., Dover, N.H.

CAPACITORS, tubular sintered anode tanta-

lum Model TAK-H operates at temperatures from -55°C to $+125^{\circ}\text{C}$ at 70 volts without voltage derating; TAK-C from -55°C to $+100^{\circ}\text{C}$ at 85 volts; TAK from -55°C to $+85^{\circ}\text{C}$. TAK operates up to 125°C by derating working voltage. All units withstand low-frequency vibration tests to MIL-STB-202 and high-frequency at 15G from 10 to 2,000 cycles without intermittent contacts, opens, short circuits or mechanical damage.—General Instrument Capacitor Div., Orange Street, Darling-ton, S.C.

SELENIUM RECTIFIERS with power capacities up to 250 va. Conduction-cooled, epoxy-sealed. Half-wave, doubler and bridge configurations in single-phase or 3-phase circuits,



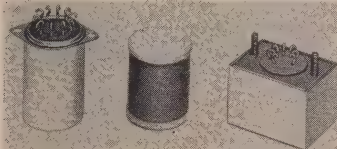
single package for up to 130-volts rms input, current outputs to 10 amps dc.—Radio Receptor Co., Inc., 240 Wythe Ave., Brooklyn 11, N.Y.

MINIATURE TRANSFORMERS. Weldable leads for high-reliability welded connections in hi-density electronic assemblies. Gold-plated nickel-



iron alloy lead wire for superior weld joints.—Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y.

TRANSFORMERS takes 11.6-volt rms, 3-phase input. Output 11.6 volts rms 2-phase. Scott transformer encased in hermetically sealed metal



container. Leads terminated by 7-pin, hermetically sealed glass header.—Supreme Transformer Co., 3911 S. Michigan Ave., Chicago, Ill.

ELECTRONIC TUBE PROTECTOR model 250 eliminates initial damaging surge currents.



Wall or floor models, for equipment drawing 100 to 300 watts.—ATR Electronics, Inc., 300 E. 4 St., St. Paul 1, Minn.

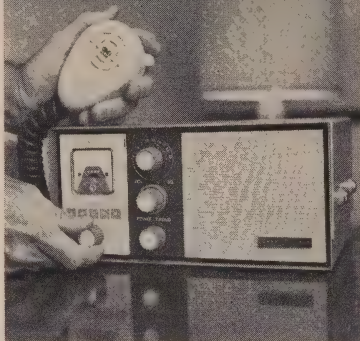
ELECTRONIC CHEMICALS in 16.4-oz spray cans. Sargent line features Red Insulator, tuner cleaner, gear and parts cleaner. Degreaser, clear



acrylic plastic, penetrating oil, squeak stopper, enamels, lacquers, metallics, engine enamels.—Sargent-Gerke Co., PO Box 729, Indianapolis 6, Ind.

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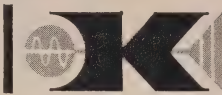
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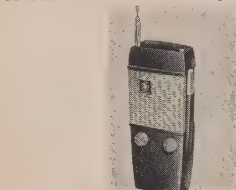
assemblies for maximum heat and fast temperature recovery. 30-watt rating with 3/16- or 9/32-inch chisel tips; 50-watt with 3/8-inch chisel tip.—General Electric Co., Schenectady 5, N. Y.

MONITOR RECEIVERS, Models MR 50X and MR 50X. Crystal-controlled split-channel instruments for remote monitoring of two-way communications. Supplied tuned to any predeter-



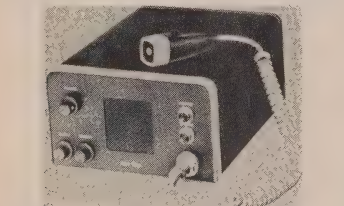
mined channel; optional channel selector for selection of up to 4 channels. Built-in whip antenna, external antenna connects when necessary. 117 volts ac. MR 50X for 25 to 54 mc, MR 50X for 147 to 174 mc.—Hannaford Mfg. Co., 460 W. 34th St., New York, N. Y.

MINIATURE 2-WAY CB TRANSCEIVER Personal Messenger. Battery-powered, contains 11 transistors and 4 diodes. Superhet receiver, rf



amplifier, 2-stage transmitter, moisture-resistant speaker/microphone, socket type battery contacts.—E. F. Johnson Co., Waseca, Minn.

CB RADIO, model Hi-104. Range up to 25 miles, power consumption 5.5 amps on 12 volts dc, or 55 watts on 115 volts ac. Harness-type



wiring, single crystal per channel for transmitting and receiving.—Hallmark Instruments Corp., 2215 Commerce St., Dallas, Tex.

MINIATURE CB RADIO, model CT-200. Transistor transmitter and receiver operate in pairs or with existing mobile and base equipment.



Power from standard 9-volt dry batteries or rechargeable nickel-cadmium batteries. Press-to-talk switch and 8-section antenna.—Polytran Industries, Inc., 1010 Howard Ave., San Mateo, Calif.

9-TRANSISTOR CB TRANSCEIVER, model GW-21, kit or assembled. Crystal-controlled superhet receiver. Rf amplifier, squelch and noise limiter, 1- μ v sensitivity for 10 db S/N ratio. Transmitter section; crystal-controlled oscillator, driver stage and modulated rf output amplifier. Maximum power input to final, 100 mw. For use without license, or for licensed operation



with class-D CB stations.—Heath Co., Benton Harbor, Mich.

VFO, model 722. Full coverage 80-10-meter. Anti-backlash tuning, low-heat silicon-diode doubler power supply, buffer-multiplier output



stage, slide-rule dial. Electron-coupled, series-tuned, 1 $\frac{1}{2}$ -inch air-core coil, temperature-compensating capacitors. High L-C ratio reduces drift.—EICO (Electronic Instrument Co. Inc.), 33-00 Northern Blvd., Long Island City, N. Y.

MULTIPLIER ANTENNA. Frequency specified upon order, gamma-tuned 72-ohm 3-, 5- and



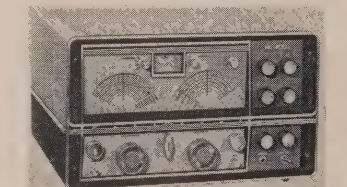
10-ohm built-in coax connector and Quick-rig construction.—Taco, Box 38, Sherburne, N. Y.

TRANSISTOR MULTIPLEX ADAPTER, model 611. Converts conventional FM tuners or receivers to stereo. ABCO contains 4 transistors;



separation 20 db from 30 to 15,000 cycles.—ABC Electronics, Inc., 611 Brookhaven Dr., Orlando, Fla.

MULTIPLE CRYSTAL ADAPTER, model MX-100 for NC-400 general communications receiver. Allows selection of up to 50 crystal-controlled channels, assures fixed channel re-



ception. Factory-installed.—National Radio Co., 61 Sherman St., Melrose, Mass.

PA AMPLIFIER, model 7061. Hi-fi circuitry throughout. Full-range controls with 20-20,000-cycle response. 2 mike inputs with independent volume controls. Circuits for mixing either or



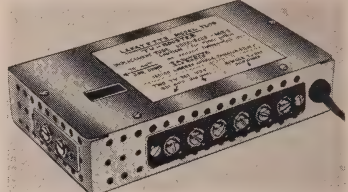
both mikes with phono input or tuner. Monitor output feeds external amplifier. Rated output 17 watts—34 watts peak; mike gain 120 db, phono 85 db; hum and noise level 65 db below rated output, output impedances 4-8-16-500 ohms (70-volt line).—Eric Electronic Corp., 1823 Colorado Ave., Santa Monica, Calif.

ANTENNA BASE, model NTS-1. Swivel ball, spring mount and all exposed metal fittings of stainless steel. Light weight reduces flexing of vehicle panel. Spring assembly features double



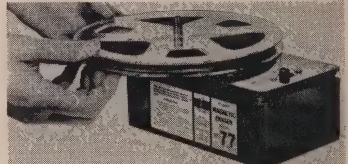
capture design and reduced length.—New-Tronics Division, 3455 Vega Ave., Cleveland, Ohio.

TV/FM BOOSTER-COUPLER, model TL-75. 4-set amplifier for signal amplification in fringe locations. Requires no tuning. Screw type antenna terminals eliminate special stripping of transmission line. Isolation circuit prevents



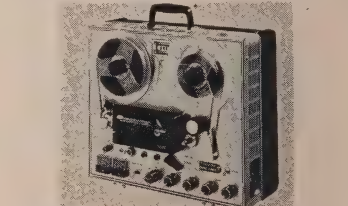
interaction and interference between sets. 117 volts ac 60 cycles.—Lafayette Radio Electronics Corp., 165-08 Liberty Ave., Jamaica 38, N. Y.

BULK TAPE ERASER, model ME-77. Removes unwanted signals from reels of magnetic tape



up to 7 inches in diameter, demagnetizes 1/4-inch tape in seconds. Erases all tracks simultaneously. Model ME-99, professional size.—Robins Industries Corp., 36-27 Prince St., Flushing 54, N. Y.

TAPE RECORDER, model S505. 2-track recorder, Reverse-O-Matic 4-track which reverses



automatically, or other configurations. Stainless steel; black knobs, meters and hardware.—American Concretec Inc., 9449 W. Jefferson Blvd., Culver City, Calif.

TAPE RECORDER, Korting MT-156. 2-track mono unit includes case, microphone, power cable,



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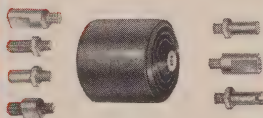
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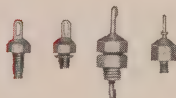
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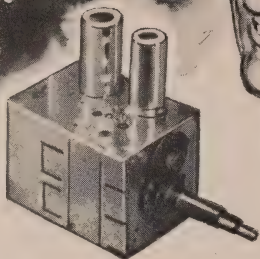
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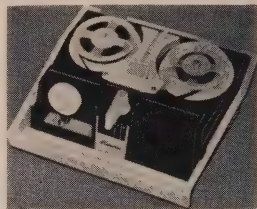
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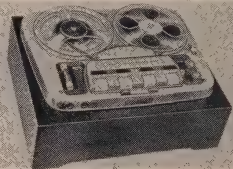
diode connection cable and empty tape reel. Tape-position indicator for forward and rewind; recording-level indicator; switchable input for microphone and radio; separate bass and treble controls; mixer pushbutton. Standard 110-120 volts ac, two speeds, response is 30-16,000 cycles at 3 3/4 ips and 30-20,000 cycles at 7 1/2 ips; wow and flutter 0.2% at 7 1/2 ips, 0.35% at 3 3/4 ips.—Kimberly Industries Ltd., 346 W. 44th St., New York, N. Y.

ALL-TRANSISTOR TAPE RECORDER. Single control for rewind, off, play, record. Crystal



micro, built-in Alnico V dynamic speaker, 2 size-D and one 9-volt transistor battery.—Edmund Scientific Co., Barrington, N. J.

TAPE RECORDER DECK, Korting model 114. 4-track stereo unit. Separate heads for record, playback, erase. Preamp equalizer for recording and playback, allowing use with external power amp only. For mono recording or playback, internal preamp equalizer may be bypassed to



use external preamp equalizer. Dubbing control dubs previous recording simultaneously onto recording track, producing multiple-synchronized recording. Response 40-15,000 cycles at 3 3/4 ips; 30-20,000 cycles at 7 1/2 ips. Wow and flutter less than 0.2% at 7 1/2 ips.—Kimberly Industries, Ltd., 346 W. 44th St., New York, N. Y.

TAPE CARTRIDGE PLAYER, model 36. Solenoid-actuated start and stop operation. Remote control operated manually or by external switching electronics actuated by tone pulse or



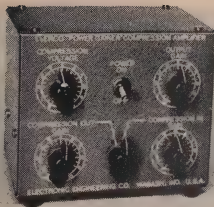
tape contactor head. Standard head bracket for 8 heads. Full-, half- or quarter-track heads. Tape speeds of 1 1/2, 3 3/4 and 7 1/2. Model 37 same with automatic cartridge lock-in reject mechanism for rapid handling of cartridges.—Viking of Minneapolis, Inc., 9600 Aldrich Ave. So., Minneapolis, Minn.

TURNTABLE-ARM COMBINATION, 33-1/3-rpm. Arm, walnut base, dust cover, cables, overhang adjustment device and needle force gauge.



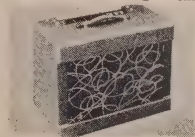
Belt drive from synchronous motor, 3.5-lb. aluminum platter, shock mountings from top plate. Tone arm floats down to record if dropped, damping mechanism disengaged when needle touches record.—Acoustic Research, Inc., 24 Thorndike St., Cambridge 41, Mass.

AUDIO COMPRESSION AMPLIFIER Power Gainer increases effective range of 2-way radio, amplifies low-level sounds to level equal to low-



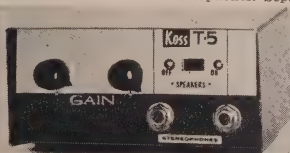
frequency voice sounds. For base-station or mobile applications.—Blenco, Electronic Engineering Co., Wabash, Ind.

PORTABLE AMPLIFIER, model PA-273WX. 5 dual-purpose tubes and 12-inch speaker deliver 15 watts output. Wide-swing tremolo control



foot-operable. 3 separate accordion, guitar and instrument output jacks. Tube complement: 1-12AX7, 1-12AU7, 2-7189, 1-6CA4.—Lafayette Radio Electronics Corp., 165-08 Liberty Ave., Jamaica 33, N. Y.

HI-FI HEADPHONE JUNCTION BOX, model T-5. Inputs for 2 sets of Stereophones. Separate



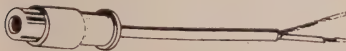
volume controls for left and right ears. Remote-control volume level plus on-off speaker switch.—Koss Electronics, Inc., 2227 W. 31st St., Milwaukee 8, Wis.

EARPHONES, Feather-Lite series. Plastic cone. Lightweight, flexible headbands. Monaural types, 8 and 100 ohms; stereo, 16/16 ohms. Also with



boom-mounted mike, impedances 50, 100 and 200 ohms dynamic, 200 and 16,000 ohms magnetic, ceramic and crystal for high impedance.—Permoflux Corp., 4101 San Fernando Rd., Glendale 4, Calif.

AUDIO ADAPTER, model 373. Converts binding post, screw- or solder-type terminals on stereo hi-fi amplifiers, tuner, speakers, record



players and turntables to phono jack terminations. 2-conductor long-handle phone jack connected to 3-inch shielded cable.—Switchcraft, Inc., 5555 No. Elston Ave., Chicago 30, Ill.

HI-FI SPEAKER SYSTEM, DuK-60. 4 reproducers and 2 crossover controls make up columnar system. Ionovac tweeter covers 3,000 to



30,000 cycles; 8-inch speaker for mid-range frequencies, 12- and 8-inch woofers for low frequencies.—Dukane Corp., Ionovac Div., St. Charles, Ill.

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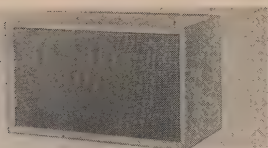
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THIN SPEAKER, Wefaire Bi-Phonic Coupler. Large panel section vibrates as single piston. Unbaffled, free unrestricted radiation on both



sides, produces double-sided, figure-8 radiation pattern, adaptable to stereo. 30 cycles to beyond audible range. 13½ x 21¼ x 3¼ inches.—Advanced Acoustics Co., 67 Factory Place, Cedar Grove, N. J.

STEREO-EQUIPPED TUNER, model SCT-4. Variable FM tuner has built-in Magic Module stereo system. Receives composite stereo signal,



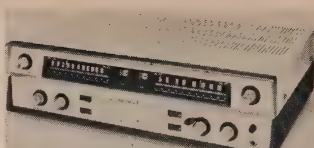
sends left and right signals through amplifiers and speakers. Sidebands carefully preserved to retain maximum stereo effect.—Karg Laboratories, Inc., 162 Ely Ave., S. Norwalk, Conn.

TAPERED HEAD, model 5QT17. 4-track stereo record and playback head. Tapered profile sim-



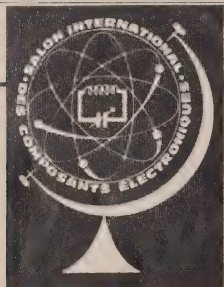
plifies insertion of cartridge tape by eliminating corners.—Michigan Magnetics, Inc., Vermontville, Mich.

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multiplex adapter. Tuning ranges: FM, 88-108 mc; AM, 535-1605 kc. Sensitivity: FM, 2 µV/98 mc; AM, 40 µV/1000 kc. Tone control 50 cycles, +15 db, -14 db; 10 kc, +15 db, -17 db. Output 30 watts per channel. Multiplex stereo circuit; FM, AFC; whistle, rumble and scratch filter; stereo phone jack.—American Commercial Inc., 212 Fifth Ave., New York 10, N. Y.

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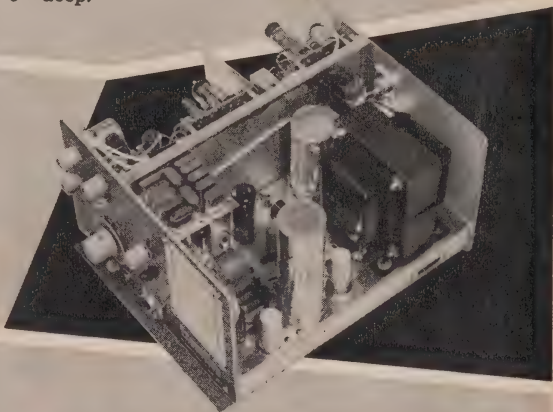
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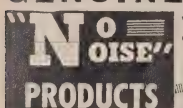
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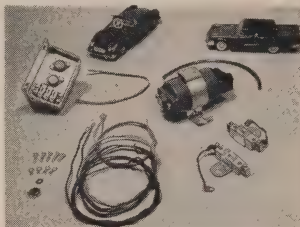
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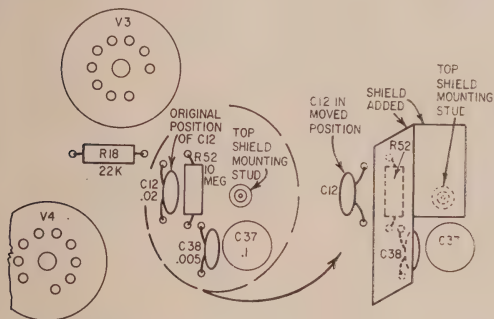
loosen the resistor board and wiring, pull the board and replace the resistor. However, there is an easier way:

1. Cut the top lead to the old R16 next to the resistor.
2. Twist off the bottom lead next to the resistor by holding it from the back of the panel with long-nose pliers and carefully twisting R16 back and forth with another pair of long-nose pliers at the top of resistor.
3. Fish the lead which went to the bottom of R16 out of the cavity and as far to the right (looking at rear of meter) as possible.
4. Solder one side of the new R16 to the wire which went to the top of the old resistor, leaving about 1 inch of lead on it.
5. Lay the new R16 in the upper part of the outer circular groove which is under the cover plate that goes over R23 and R24.
6. Connect the other side of the new R16 to the lead which was fished from the bottom of the cavity, by going around the right side of the molded plate. (Cover the resistor lead with spaghetti.)
7. File the cover plate so that it will seat around the resistor. This is important because the meter fits into the case with very little clearance.—*Art Bennett*

ALLIED 83 YX 774

To prevent the right-channel signal from coupling to the left channel, especially at low volume, install an additional shield as shown.

The circuit diagram of the set reveals that R52, C38, C37 belong to the right-channel rumble filter and C12 is the left-



channel coupling capacitor. Thus the right channel signal couples through this capacitor to the left channel.

Installing the additional shield around these parts, mounted on the same stud where the original top shield plate is anchored, eliminated the coupling.—*Themistocles Q. Sarmiento*

RCA 17-S-6022

Some of these sets develop a buzz which is heard at all settings of the volume control. Sometimes the buzz is caused by the lead which connects resistor R109 to the 200,000-ohm tape on the volume control touching the control's case. Slip a piece of spaghetti over the lead, wrap a piece of tape around it or simply dress the lead away from the control to cure this trouble.—*Warren Roy* END

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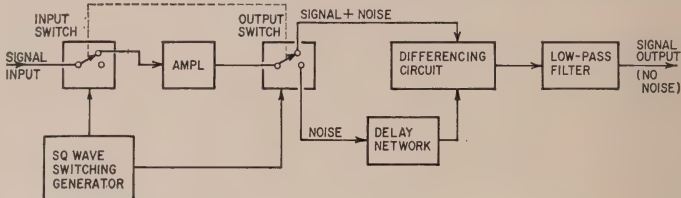
NOISELESS CIRCUIT

Patent No. 2,970,276

Kenneth Dollinger, Derry, N. H.

(Assigned to Raytheon Co.)

The input and output switches are synched by the square wave. In the position shown, the signal plus noise generated in the amplifier passes arrive simultaneously. Since the differencing circuit subtracts one voltage from the other, when the two noise signals arrive, they cancel and are



into a differencing or subtractive circuit. In the other position, noise only is passed to the differencing circuit. The noise is delayed slightly so that both (noise plus signal) and (noise alone)

eliminated.

The low-pass filter eliminates the square wave, whose frequency is much higher than that of the signal.

DIGITAL TO ANALOG CONVERTER

Patent No. 2,970,308

George S. Stringfellow and Erwin J. Emkjer, San Diego, Calif. (Assigned to General Dynamics Corp., San Diego)

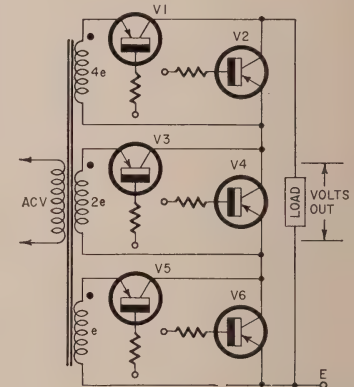
In binary arithmetic, only powers of 2 are used: 1, 2, 4, 8, ... This device receives binary information corresponding to a given number, and delivers a voltage equal to the sum. Each of the binary stages is labeled e, 2e, 4e and so on. Only three stages are shown.

Binary information from a computer or tape machine is fed in, each digit going simultaneously to the corresponding stage. For example, if the number is 5, stages e and 4e will be energized, stage 2e remaining off. Each energized stage delivers a voltage from its transformer secondary, which is specially wound to generate the proper voltage. All secondaries are similarly poled.

Each stage contains a pair of switching transistors, such as V1, V2. Normally, odd-numbered transistors are blocked by a positive base voltage. Also, even-numbered transistors conduct due to a negative base voltage. E, a reference voltage, is at ground potential.

To energize a stage, bias voltages at the transistor bases are reversed. Therefore the odd-numbered transistor of such a stage is driven to conduction and delivers the required voltage from its transformer coil. At this time the even-numbered transistor becomes an open switch.

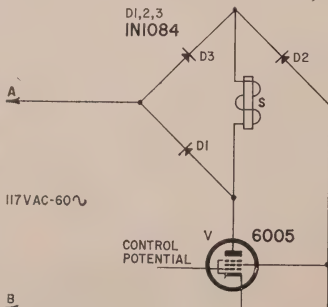
In each stage, one transistor is conducting at any time. Thus the same dc voltage, E, is at all emitters and collectors. The transistors are activated by ac from the transformer.



CONTROL CIRCUIT

Patent No. 2,970,247

Frank W. Hill, Moline, Ill. (Assigned to Gamewell Co., Newton, Mass.)



A weak signal to tube V controls heavy current through the solenoid. The diodes are silicon types IN1084 rated at 500 ma. The tube is a 6005.

The ac line is represented by A, B. When A goes negative, load current flows through D1, the solenoid and D2. If the grid signal is negative, V blocks during the other half-cycle. With only half-wave power supplied to it the solenoid is not fully energized.

When the grid goes positive, V conducts when A goes positive. The path is through D3, the solenoid and V. Only under this condition full-wave power flows through the solenoid to energize it fully.

END

THE WOMEN COMPLAIN

New York—Of all complaints made against service technicians by women, two-thirds are attributed to lack of interest and discourtesy, according to Miss Willie Mae Rogers, director of the Good Housekeeping Institute. This statement was made at an Electronic Industries Association conference and reported by *Home Furnishings Daily*.

Miss Rogers gave six main items as the leading complaints: inefficient service; delay in getting a technician to call; unavailability of parts; the "attitude" of the service technician; cost, and broken appointments.

To eliminate these problems, five things that every technician should be taught were suggested—knowledge of the product and how to repair it; neatness; courtesy; responsibility for leaving a house as it was found, and confidence in the product.

CAPTIVE SERVICE—1988

The following item is pure fiction. It is one man's view of what captive service and extended warranties may turn into. It is an item important to every service technician.

THE CAPTOR SPEAKS

By T. F. SINCLAIR

MEMO
To: All Little Wonder Sales and Service Dealers
From: J. R. Hamilton, Vice President, Little Wonder Service Co.

GENTLEMEN:

In light of some recent findings furnished this office by the Garies Security Agency, it appears that our captive service policy is in need of additional safeguards. The Garies Agency reports that even though all service literature and schematics for our *Little Wonder* television receiver are distributed only to authorized sales-service shops some of this material is falling into the hands of outsiders (independents). It is further rumored that persons unknown are surreptitiously supplying an underground network of independents with the recent circuit modifications that we have been employing as a confusion tactic. The immensity of this problem is evident. We may be deprived of our advantage over the independent and be forced to compete with him on a "may the best shop win" basis. This must never be!

To regain our tenable position in the servicing field I have presented a list of suggested model changes and service procedures to the *Little Wonder* front office. The proposals are outlined below:

1. All *Little Wonder* television receivers shall be provided with a tamperproof cabinet. Access to the electronic circuitry will be provided by a locked rear panel. Authorized *Little Wonder* service dealers will be provided with one key and, to safeguard its use will be required to post a \$500 bond. If this key is lost or is missing from a

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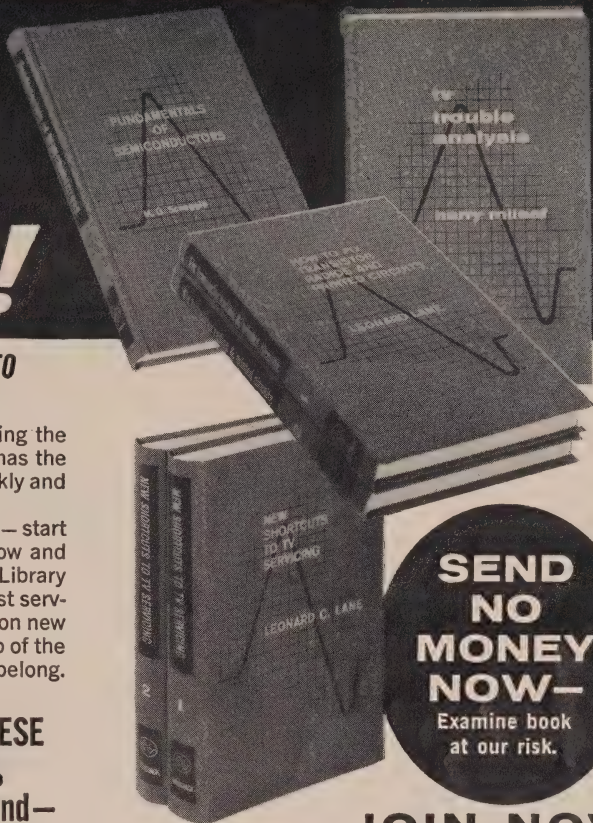
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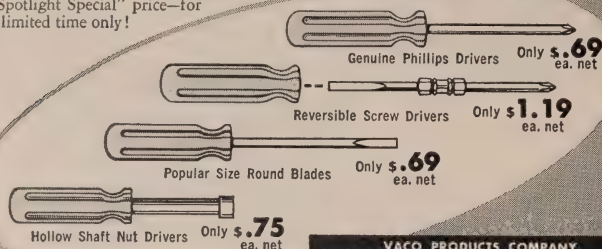
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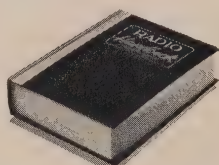
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Begins with magnetic theory and covers iron-core and air-core types. Simple math and examples show applications in amplifiers, power supplies and control devices.

RAPID AUTO RADIO REPAIR, by G. Warren Heath. Howard W. Sams & Co., Inc., 1726 E. 38 St., Indianapolis, Ind. 5 1/2 x 8 1/2 in. 158 pp. \$2.95.

All types of auto sets are discussed: FM, foreign, hybrid, printed-circuit. Text and diagrams are keyed for speed in servicing.

SOLAR CELL AND PHOTOCCELL HANDBOOK, International Rectifier Corp., El Segundo, Calif. 6 x 9 in. 112 pp. \$2.

This book describes the cells and tells how to use them. Contains elementary radiation theory, and describes over 75 practical, easy-to-build projects.

TV RECEIVER SERVICING, (Vol. 1), by E. A. W. Spreadbury. Iliffe Books, Ltd., Dorset House, Stamford St., London, S.E. 1, England. 5 1/2 x 8 1/2 in. 364 pp. 25 shillings.

Author includes unusual problems and topics: spot wobble, picture expanders, protection against implosion, X-rays, etc.

INTERNATIONAL DICTIONARY OF PHYSICS AND ELECTRONICS (2nd Edition). Edited by Walter C. Michels, Rosalie C. Hoyt and Joseph C. May. D. Van Nostrand Co., Inc., Princeton, N.J. 7 1/2 x 10 1/2 inches. 1355 pages. \$27.85.

New edition is 350 pages larger than the first, printed in 1956, covering a large number of terms added by the advance of science.

STEREOPHONIC SOUND (2nd Edition), by Norman H. Crowhurst. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N.Y. 5 1/2 x 8 1/2 in. 136 pp. \$2.90.

Plain language, diagrams and photos combine to tell the story of stereo for the home listener. Covers FM, disc, tape.

CROSSED-FIELD MICROWAVE DEVICES. Edited by E. Okress. Academic Press, 111 Fifth Ave., New York 3, N.Y. 6 x 9 in., Vol. 1. 648 pp. \$22. Vol. 2. 520 pp. \$18.

Many physicists have contributed to these volumes, analyzing the devices, working out basic theory and discussing the problems. Vol. 1 deals with the principal elements. Vol. 2 covers types, analysis and developments in US, France and Japan.

THE STORY OF ATOMIC ENERGY, by Laura Fermi. Random House, 475 Madison Ave., New York, N.Y. 6 x 8 1/2 in. 178 pp. \$1.95.

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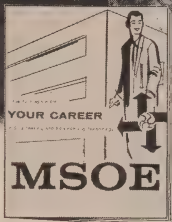
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CORRECTION

There is a discrepancy between the schematic and transmitter printed-circuit board in the four-channel radio-control system on page 32 of the November issue. The schematic shows pins 1 and 7 of V1, V3 and V4 going to ground (A- and B-) while on the circuit board they connect to A+. The change is made automatically if you use the board in Fig. 4. If you use ordinary point-to-point wiring on the transmitter, connect the filament center taps of all tubes, including V2, to A- and connect pins 1 and 7 of all tubes to A+.

We thank Mr. Marvin Livingston, of Stillwater, Okla., for bringing this to our attention.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF RADIO-ELECTRONICS published monthly at Mount Morris, Ill., for Oct. 1, 1961.

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Acoustic Research Inc.	101
Aerovox Corp.	20
Allied Radio Corp.	23, 75
Almo Radio Co.	100
American Elite	67
American Microphone Div. of GC Electronics	64
Audio Unlimited Inc.	124
Audion	113
B&K Manufacturing Co.	65
Barry Electronics Corp.	106, 109
Bell Telephone Labs	18
Blonder-Tongue Labs	26-27
Broad Radio & TV Corp.	118
Burstein-Applebee Co.	113
Capitol Radio Engineering Institute	16-17
Carlton Press	112
Carston	112
Castle TV Tuner Service	109
Centralab Div. of Globe-Union	73
CLASSIFIED ADS	126-127
Cleveland Institute of Electronics	113
Coloradaptor	113
Commissioned Electronics Co.	113
Consolidated Instruments Div. of National Radio Institute	66
Coyne Electrical School	117
DeVry Technical Institute	7
Dressner	124
Duotone Co. Inc.	101
Editors & Engineers	124
Electro-Voice Inc.	92
Electronic Chemical Corp.	116
Electronic Instrument Co. (EICO)	28
Electronic Measurement Co.	89
Electronic Publishing Co. Inc.	124
Federazione Nazionale de Industrias Electroniques	114
Fisher Radio Corp.	72

GC Electronics	64
General Instrument Capacitor Div.	81
Gernsback Library Inc.	123
Grantham School of Electronics	15
Greylock Electronics	64
Grove Electronic Supply Co.	116
Harman-Kardon Inc.	120
Head's Engineering College	112
Heath Co.	62-63
Holt, Rinehart & Winston Inc.	24-25
Hudson Specialties Co.	97
Indiana Technical College	91
International Crystal Manufacturing Co. Inc.	115
Kaar Engineering Co.	112
Key Electronics Co.	92
Lafayette Radio	78-79
Mercury TV Tuner Service	121
Miller (J. W.)	100
Moss Electronic Inc.	102-105
National Radio Institutes	19-20, 66, 109
National Technical Schools	98
Newport Manufacturing Co.	5
Olson Electronics	91
Pacotronics Inc.	93-96
Picture Tube Outlet Inc.	112
Progressive Edu-Kits Inc.	123
RCA Electron Tube Div.	Back Cover
RCA Institutes	68-71
RCA Test Equipment	12
Rad-Tel Tube Co.	128
Remington Rand Univac	92
Rider (John F.) Publisher Inc.	121
Robins Industries	100
Rohn Manufacturing Co.	97
RTS Electronics Div.	13

Sams (Howard W.) & Co. Inc.	9, 74
Schober Organ Co.	108
Scott (H. H.) Inc.	3
Semiconics	8
Sencore	87
Sonar Radio Corp.	109
Sprague	111
Stancor Electronics Inc.	119
Standard Koolsman Industries	Inside Back Cover
Superscope Inc. (Sony)	99
Switchcraft Inc.	101
Sylvania Electric Products Co.	107
TAB	122
Transvision	77
Trilet Electrical Instrument Co.	Inside Front Cover
Turner Co.	76
University Loudspeakers Inc.	14
Vaco Products Co.	124
Warren Distributing Co.	91
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SCHOOL DIRECTORY PAGE 125

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2EM4	.43		GCY5	.70	12DT7	.79		
3DG4	.85		6DA4	.68	12DT8	.79		
3DG6	.60		6DT8	.79	12DW8	.89		
5AS8	.86		6EB5	.72	12EM6	.79		
5BT8	.83		6EM5	.76	12EN6	.78		
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1DN5	.55		6AH9	.99	6F8	.75	12CU5	.58			
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1R5	.62		6AL5	.47	6H6	.58	12CX6	.54			
1S2A	.76		6AL7	1.43	6J5GT	.51	12D85	.69			
1S4	.59		6AM4	1.50	6J6	.67	12D8	.75			
1S5	.51		6AM8	.78	6K6	.63	12D18	.85			
1T4	.58		6AQ5	.53	6L6	1.06	12D66	1.04			
1U4	.57		6AR5	.55	6N7	.98	12D57	.79			
1U5	.50		6AS5	.60	6S4	.51	12D07	1.01			
1V2	.50		6AS6	.80	6SA7GT	.76	12DW8	.89			
1X2B	.82		6AT6	.43	6SG7GT	.41	12D26	.56			
2AF4	.96		6AT8	.79	6SH7GT	.49	12ED5	.69			
2BN4	.64		6AU4	.82	6SJ7	.88	12EG6	.54			
2EA5	.70		6AU6	.52	6SK7GT	.74	12EK6	.56			

2E55	.68	6AU7	.61	6SL7GT	.80	12EL6	.50
3A3	.76	6AU8	.87	6SN7GT	.65	12EZ6	.53
3A4	.60	6AV6	.41	6S07	.73	12F8	.66
3AF4	1.02	6AW8	.90	6T4	.99	12F86	.79
3AL5	.42	6AX4	.66	6V8	.85	12FM6	.43
3AU6	.51	6AX5	.74	6U8	.83	12FR8	.91
3AV6	.41	6AX7	.64	6V6GT	.54	12FX8	.85
3BA6	.51	6BA6	.50	6V8	.86	12GC6	1.06
3BC5	.54	6BA7	.84	6W4	.60	12J8	.84
3BE6	.52	6BA8	.88	6W6	.71	12K5	.65
3BN6	.76	6BC5	.61	6X4	.39	12L6	.58
3BU8	.78	6BC7	.94	6X5GT	.53	12SA7	.92
3BY6	.55	6BC8	.97	6X8	.80	12SF5	.50
3BZ5	.55	6BD5	1.25	6Y6	.65	12SF7	.69
3CB6	.54	6BE6	.55	7A8	.68	12SH7	.49
3CF6	.60	6BF5	.90	7AU7	.61	12SJ7	.67
3CS6	.52	6BF6	.44	7B6	.69	12SK7	.74

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3S4	.61	6BJ6	.62	7Y4	.69	12U7	.62
3V4	.58	6BJ7	.79	8AU8	.83	12V6	.53
4AU6	.54	6BK7	.85	8AW8	.93	12W6	.69
4BA6	.51	6BL7	1.00	8B05	.60	12X4	.38
4BC5	.58	6BN4	.57	8C7	.62	17AX4	.67
4BC8	.96	6BN6	.74	8CN7	.68	17B06	1.09
4BN6	.75	6BQ5	.65	8CN7	.97	17D4	.69
4BQ7	1.01	6BQ6	1.05	8CS7	.74	17DE4	.74
4BS8	.98	6BQ7	1.00	8CX8	.93	17DQ6	1.06
4BU8	.71	6BR8	.78	8E8	.94	17L6	.58
4BZ6	.58	6BS8	.90	8SN7	.66	17W6	.70
4BZ7	.96	6BU8	.70	9CL8	.79	19AU4	.83
4BZ8	1.10	6BX7	1.02	11CY7	.75	19BG6	1.39
4CS6	.61	6BY5	1.15	12A4	.60	19C8	1.14

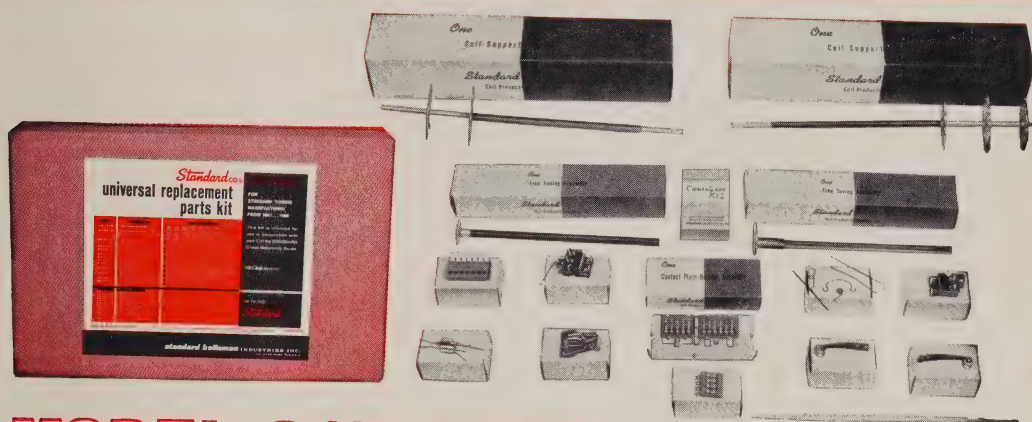
4DE6	.62	6BY6	.54	12AB5	.55	19T8	.80
4DK6	.60	6BY8	.66	12AC6	.49	19V8	.79
4DT6	.55	6BZ6	.55	12AD6	.57	21EX6	1.49
4EW6	.58	6BZ7	1.01	12AE6	.43	25AV5	1.83
5AM8	.79	6BZ8	1.09	12AE7	.94	25AX4	.70
5AN8	.86	6C4	.43	12AF3	.73	25BK5	.91
5AQ5	.52	6C8	.90	12AF6	.49	25BQ6	1.11
5AT8	.80	6CB6	.55	12AF6	.46	25C5	.53
5AV8	1.01	6CD6	1.42	12AL5	.45	25CA5	.59
5AZ4	1.41	6CF6	.64	12AL8	.95	25CQ6	1.11
5BC8	.79	6CG7	.61	12AQ5	.60	25DQ6	1.42
5BE8	.83	6CG8	.77	12AT6	.43	25EH5	.55
5BK7	.82	6CL8	.79	12AT7	.76	25H5	.57
5BQ7	.97	6CM6	.64	12AU6	.51	25L6	.68
5BR8	.79	6CM7	.66	12AU7	.60	25W4	.66
5CG8	.76	6CN7	.65	12AV6	.41	25Z6	.66
5CL8	.76	6CQ8	.84	12AV7	.75	32ET5	.55

5CQ8	.84	6CR6	.51	12AX4	.67	32L7	.90
4CY5	.71	6CS6	.57	12AX7	.63	35B5	.60
5EA8	.80	6CS7	.89	12AY7	1.44	35C5	.51
5EUB	.80	6CUS	.58	12AZ7	.86	35L6	.57
5F4	.68	6CU6	1.08	12B4	.63	35W4	.42
5F4	.79	6C77	.71	12B6	.50	35Z5	.60
5F8	.81	6DB5	.69	12B47	.84	36AM3	.36
5U4	.60	6DB6	.51	12BD6	.50	50B5	.60
5U8	.81	6DE6	.58	12BE6	.53	50C5	.53
5V3	.90	6DQ6	.59	12BF6	.44	50EH5	.55
5V6	.56	6DK6	.59	12BGT	.77	50L6	.61
5X8	.78	6DN6	1.55	12BK5	1.00	5744	1.50
5Y3	.46	6DQ6	1.10	12BL6	.56	57B3	1.00
5Y4	.59	6DT6	.53	12BQ6	1.06	57B4	1.50
6AG6	1.20	6EA8	.79	12BR7	.74	70L7	.97
6AB4	.46	6EB8	.94	12BVT	.78	70Z5	.69
6AC5	1.05	6EM7	.82	12BVT	.77	84/6Z4	.46
6AC7	.96	6EUB	.79	12BZ7	.75	807	.70
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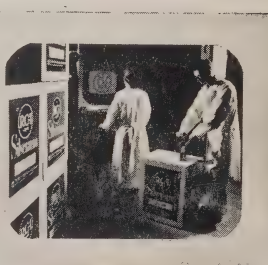
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1961 ANNUAL INDEX

Vol. XXXI, January-December, 1961

RADIO-ELECTRONICS

A

Air Conditioner, Ultrasonics Controls (Mawell)	Jul 46
Alarm Burglar, Composite-Transistor	Jun 61
Alarms, Emergency in Your Home	Mar 82
Amplifiers—See Audio, Electronic(s), TV	
Anti-Chatter-Capacitors (Darling)	Dec 46

AUDIO—STEREO—HIGH FIDELITY

Amplifier(s)	
Feedback, Puzzled About? (Crowhurst)	Feb 69
from Old TVs (CI)	Nov 59
General-Purpose, Composite-Transistor	Jun 64
Mini-pack (Frantz) Apr 50; (Corr)	Jun 89
Remote Has 4-transistor Circuit (Waslo)	Mar 96
Stereo, Quality (Laurent)* (Corres)	May 35
Stereo (Scott LK-72)†	Jul 20
Transistor, 2-tape (NC)	Sep 62
Wide-band (Post)	Jul 100
Crossover, All-Transistor Electronic (Meyer)*	Feb 102
Feedback, Puzzled About? (Crowhurst)	Jun 37
Hi-Fi, Puzzled About (Crowhurst)	Feb 69
Matching, Taking Mysticium Out of (Ravenswood)	Jun 36
Noise Limiter (Pat)	Jul 56
Organ(s)	Sep 120
Add Percussion to Electronic (Korte)	Sep 92
Strobe Instrument Tuners (Dorf)	Feb 42
Output, Quality (Pat)	Oct 126
Phono-Plug Adapter (Trauffer)	Jul 50
Phono Tuning Device (Pat)	Nov 137
Plug, Easy-to-Connect (Corres)	Feb 49
Power Transformer, Old-Timer Helps Replace (Darr)	Nov 109; Dec 52
Preamplifier(s)	
Custom Hi-Fi Design (Horowitz)	Mar 46
Decade Type, Two (Scholz)*	Aug 32
Stereo Quality (Williams)*	Oct 54
Transistor P-C Stereo (Meyer)* (Corr)	Jan 117; Apr 106; (Corres)
Record, 30-Day LP (Fiction) (Fips)	Feb 26
(Corres)	Apr 56
Reverberation (Corres)	Jun 22
Enhances Hi-fi audio (Scott)	Dec 34
improved	Jan 24
Speaker(s)	Jan 75
Compression, Improved (Pat)	May 104
Corner Best? (Corres)	Oct 24
Electrostatics, Full-Range, Are Here (Fried)	Jul 30
Enclosures, Bass-Reflex	Aug 40
New, Only 4 Inches Thin (Steckler)	Nov 78
Rotate Stereo (Corres)	Feb 20
Smaller, As Things Get (Corres)	Apr 22
System Phasing	Aug 68
Speed Test Loop (Stone)	Sep 68
Stereo	
AM, No, Says FCC (NB)	Dec 8
Amplifiers	
Quality (Laurent)*	May 35
Corres	Aug 40
Phones to Mono Phones (Trauffer)	Oct 85
Pickup Arms, New (Marshall)	Nov 43
Pickup Arms, Specifications for new (Steckler)	Nov 46
Preamplifier, Quality (Williams)* (Corres)	Nov 54; Dec 22
Speaker(s)	
How to Place (Augspurger)	Oct 91
Rotate (Corres)	Feb 20
System, Convert for No. 20 (Lichten-walter)	Mar 59
Without Amplifiers (WN)	Dec 55
Underwater (Corres)	Jan 20
Tape Recorders, Servicing (Darr)	Sep 59
Brakes and Pressure	Jun 56
Level Indicators and Tape Erasing	May 47; (Corres)
Mikes, Amps, Bias-erase Oscillators	Jul 18
Recording Head	Jul 78
Switching, Electronic and Mechanical	Aug 39
Tone Control, Unusual (NC)	Sep 114
Tremolo (Pat)	Sep 120
Volume Control, Constant-Setting (Ives)	Dec 57
Wait, Where's the (Corres)	Apr 28

Automobile

Ignition, Electronic (Corres)	Sep 24
Ignition System, Electronic (Smithy)* (Corres)	Sep 34; Dec 21
Ignition System (Pat) Apr 90; (Corres)	Jun 18; Aug 18
Radios (see Radio)	
Tail-light Monitor (NC)	Apr 108

B

Banana Tube Is Color CRT (Leslie)	Dec 39
Breadboarding, Industrial Electronic (Squires)	Aug 82

C

Case of Missing Spot (Karrol)	Mar 92
Circuit Substitution Speeds Transistor Radio Servicing (Borlaug)	Jan 85
Citizens Band—see Radio	

KEY TO SYMBOLS AND ABBREVIATIONS

* Construction Articles	
† Section of full-length article	
CI	Television Clinic
Corr	Correction
Corres	Correspondence
NB	News Briefs
NC	Noteworthy Circuits
Pat	New Patents
Tech	Techniques
TTO	Try This New
WN	What's New

Regular departments not itemized are Business and People, New Books, New Literature, New Products, Technicians' News.

Communications on 450,000,000 mc (Collins and Nelson)	May 57
Communicator, New Short-Range (Foy)	Jan 80
Consonal	
Third Station Coming (NB)	Dec 10
What Is It? (Robberson)	Mar 54
See—see Radio	
CW—see Radio	

D

DeForest, What Did He Really Invent? (Shunaman)	Sep 47
Diathermy, Case of Reluctant (Bukstein)	Apr 80
The Protection, Radio-Controlled (Darling)	Mar 86
Diodes, Do It With (Stoner)	Feb 38
Diodes, Four-Layer and Controlled Rectifiers—What are they? (Jackson)	May 44
Don't Do Half A Job (Davis)	Jul 40
Draw . . . Shoot (Wortman)*	Jun 47

E

Editorials (written by Hugo Gernsback unless otherwise noted)	
Anti-plane-collision Radar Mar 33; (Corres)	Oct 24
Extra-terrestrial TV	Apr 31
Inventions Wanted	May 31
Leo de Forest, Father of Radio, 1873-1961	Sep 33
Lunar Radio and TV Traffic	Dec 29
Man Into Space?	Jan 27
Radio Communications Threatened?	Nov 31
Radio Power	Jul 24
Sea Hunt (Corres)	Jan 99
Undersea Radar	Jan 31
Upheaval in Electronics	Feb 33
Urgency Radios	Aug 25
Education	
Closed-Circuit Across Narragansett Bay (NB)	Dec 8
Electronics, Modern School Teacher (Leslie)	Nov 38
Sound Systems in Schools and Industry (Johnson)	Sep 38
Out of Air (NB)	Aug 8
TV Classroom Takes to Air (NB)	Aug 8
Effects You Should Know (Thomas)	Feb 18; (Corres) Apr 22, Nov 18

ELECTRONICS(S)

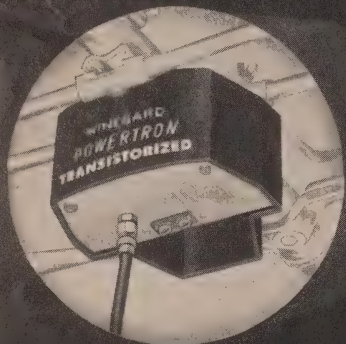
Alarm Burglar, Composite-Transistor	Jun 61
Alarms, Emergency in Your Home	
Amplifier	
Dc, Sensitive (Pat)	Mar 115
Temperature-Compensated (Pat)	Oct 127
Transistor, Selective (NC)	Jun 100
Tube-Transistor (Pat)	Jul 103
Unity Gain (Pat)	Jan 111
Autotransformers, Variable, Add Pilot Light to (Ives)	Oct 66
Batteries, Bugs in New? (NB)	Aug 6
Bridge Gate, Diode (Pat)	May 105
Cathode Heats in 1/10 Second (NB)	Aug 6; (Corres)
Chorinor (NC)	Dec 21
Coils, Find R, L and Z of Iron-Core (Gheorghiu)	May 99
Communications on 450,000,000 MC (Collins and Nelson)	Apr 76
Computer, Learns by Trial And Error (NB)	Nov 6
Control Circuit (Pat)	Dec 120
Delay Line, Ultrasonic, Works With Light at HF (NB)	Feb 10
Demagnetizer, Watch	Mar 80
Draw . . . Shoot (Wortman)*	Jun 47
Driving, Safe With Closed-Circuit TV	
Dry Cell (Stoner)*	Feb 80
Earth's Field, New Light on (NB)	May 40
Education (see Education)	Jul 8
Effects You Should Know (Thomas)	Feb 31; (Corres) Apr 22; Nov 18
Flasher Lamp (Pat)	Aug 99
Flasher (Marriner)	Apr 43
Fuses Work, How (Steckler)	Sep 50
Heat to Electricity (Aisberg)	May 58
Heater Supply, Regulated Dc (NC)	Jan 114
Hum, Earth Has (NB) Mar 10; (Corres)	Jan 6
Hurricanes Spotted (NB)	Oct 72
Ignition (Corres)	Sep 76

Ignition System for Car (Smithy)* (Corres)	Sep 34; Dec 21
Judge Spots Winner (Garson)*	Jun 74
Kits Teach (Steckler)	Jun 40
L-C Reactance Nomo Saves Calculation (Salva and Morey)	Feb 62; Mar 81
Laser Produces Blue Note (NB) (Corr)	Mar 81
Length Standard, World Has New (NB)	Jan 6
Light Beam, Talk on (Pittet)*	Sep 56
Light Meter	
Sensitive, Directional (Tullsen)* (Corres)	Jul 37; Nov 8
Ultrasensitive Photographic (Gordon)*	Oct 43
Light Wave, Communication by Magnets, Super, Possible With New Alloy (NB)	Mar 49
Master Amplifies Light (NB)	Apr 18
For Sound (NB)	Nov 8
Light Source (NB)*	Sep 8
Produces Blue Note (NB)	Oct 6
Medicine (see Medicine)	Nov 6
"Micrologic" Elements Cut Digital Circuit	Jun 6
Microscope Shoots "Live" (NB)	May 8
Microwave Communications System in Canada (NB)	Oct 18
Miss Universe, Electronics Engineer Be-comes (NB)	Sep 6
Monitor Is Wide-Range Timer (Wrigley)*	Aug 73
Motor World's Smallest Electric	Jul 54
Music into Light (TTO)	Aug 97
Music Pick (Pat)	Jun 93
Nuclear Thermoelectric Power (WN)	Dec 55
Noiseless Circuit (Pat)	Dec 120
Numbers Puzzle (Comstock)	May 68
Ohm NBS Relates (NB)	Nov 8
Oscillator, Coil-less Crystal (Taylor)	Aug 49
Pathlighter (Winklepleck)*	Sep 50
Photoelectric Circuit, Heavy-Duty (NC)	Jun 100
Photoflash	
Inside Electronic (Henry) Mar 36; (Corres)	Jun 18
Slave, Composite-Transistor	Jun 61
Phototube, Gallium Arsenide Highly Sensitive (NB)	Oct 8
Psychology Laboratory (Bopkins)	Jul 82; Oct 26
Radio-Control System, 4-Channel (Siebel)*	Nov 32
Radio Telescope, Australian, Mile Long and Wide (NB)	Feb 8
Radio Telescope, Russian (WN)	Nov 42
Reactance, L-C Nomo Saves Calculation (Salva and Morey) Feb 52; (Corr)	Mar 81
Rectifier (Pat)	Mar 115
Refrigerator Announced by Hitachi (NB)	Mar 8
Relays (see Relays)	
Remote-Control System (Pat)	Aug 99
Remote Control TV Uses 1 Tube (Sylvania)	
(De Marius)	Feb 56
Remote Indicator, Light-Heat (Rethbun)	Nov 99
Resistor, Power (Lederer)	Nov 107
RF Breaks Rock (NB)	Dec 10
Satellite	
Ionosphere (NB)	Jan 12
Senate Committee Charges Neglect of Radio (NB)	Feb 10
Schoolteacher, Modern (Leslie)	Nov 38
Seismograph Tested, "Missile" (NB)	Jul 16
Semiconductors (see Semiconductors, also Specific Subject)	
Shooting Gallery (Pittet)*	Dec 50
Sonar Works, How (Glennon)	Oct 34
Gauge Measures Atmospheric Density (WN)	Oct 53
Ionosphere, Do-it-yourself (NB)	Dec 8
Ion Engine, Practical May Give Edge	
Klystron Tube for Outer (Jashi)	Dec 6
Moon, To Pix to Come From (NB)	May 6
Radiome Largest (WN)	Dec 55
Ships, RF to Propel?	Nov 34
Space Craft Not Germ Carriers (NB)	Dec 6
Superconductors (NB)	Oct 18
Switch, Repeating (Wilensky)	Oct 77
Telephones Go Electronic (NB)	Jan 12
Telephone, Talk in Pulses on (NB)	Oct 6
Thermogenerator, Compound (NB)	Feb 6
Xerone, Powers Transistor Radio (NB)	Sep 6
Thermostat, Bridge (Pat)	Mar 115
Time-Delay Circuit, Simplified (Hamilton)	Apr 51
Time-Signal Accuracy, Canadian Station Improves (NB)	Feb 6
Timing Device (Pat)	Oct 6
Tornadoes, New System May Track (NB)	Jul 6
Tunnel Diodes (see Tunnel Diodes)	
Voltage Discriminator (Pat)	Aug 99
Voltage Regulator (Pat)	Oct 126
Watch Demagnetizer	Mar 80
Watch Repair	May 42
Wireless Power Transmission (NB)	Jun 12
Ultrasonics (see Ultrasonics)	
X-Ray, New Tube Speeds Photos (NB)	Apr 18
Emergency Alarm In Your Home	Mar 82
EQ, What's Your	
Automated Voting	Sep 49
Black Box	Nov 73
Black Box Brain	Nov 73

Why the WINEGARD ELECTRONIC MOST EFFECTIVE TV ANTENNA...

**DESIGNED TOGETHER
TO WORK TOGETHER... WINEGARD
POWERTRON ANTENNA AND
BUILT-IN AMPLIFIER!**


TRANSISTORIZED!





MODEL SP-55X


"By FAR world's most powerful all-channel antenna!"


WHY? BECAUSE...


 **IT CAPTURES MORE SIGNAL** than any other all-channel antenna ever made. Patented design, electro-lens director system, dual "TAPERED T" driven elements, 30 precision-tuned elements in all.

 **IT'S THE ONLY TRUE ELECTRONIC ANTENNA.** Only the Winegard Powertron is built with the amplifier as part of the driven element—not an "add-on" attachment.

 **IT ELIMINATES ALL SIGNAL LOSS** that normally occurs between the driven element and the amplifier due to transmission and coupling mis-match.

 **IT BOOSTS WEAK SIGNALS UP OUT OF THE SNOW** far better than any other antenna or antenna-amplifier combination made.

 **FOR VIVID COLOR, HIGH DEFINITION BLACK AND WHITE AND LONG DISTANCE RECEPTION,** nothing can compare to the Super Powertron. Thousands have been installed all over the country and our files are full of testimonials from grateful TV viewers and Service-Technicians alike.

 **WINEGARD IS THE ONLY MANUFACTURER THAT MAKES BOTH ANTENNAS AND RF AMPLIFIERS.** Because of this you can feel confident of getting the very best. But don't take our word for it—let your eyes and ears and field strength meter tell the story.



MODEL P-55
Powertron — transistORIZED, 14 elements.



MODEL P-55X
Powertron with Pack — TransistORIZED, 21 elements.



MODEL SP-55X
Super Powertron — transistORIZED, 30 elements.

POWERTRON is by far WORLD'S

Not 60%...Not 70%...but over 95% efficient

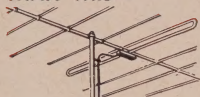
OUTFEATURES—OUTPERFORMS ORDINARY ANTENNAS WITH "ADD-ON" TYPE SIGNAL BOOSTERS!

THIS IS BETTER—

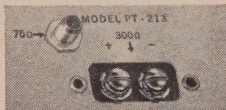


Exclusive amplified "Tapered T" driven element for perfect match and lowest possible signal-to-noise ratio. Only Powertron has it.

THAN THIS—



Not an after-thought "add on" signal booster hung on an ordinary antenna—not an old fashioned mast mounted booster.

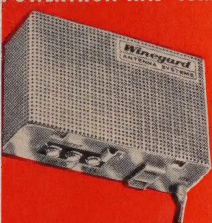


ONLY POWERTRON HAS BOTH 300 OHM TWIN LEAD OR 75 OHM COAX TERMINALS ON BUILT-IN AMPLIFIER.

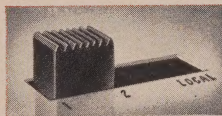


ONLY POWERTRON GIVES YOU YOUR CHOICE OF TRANSISTORS OR TUBES (TUBE MODELS 300 OHM ONLY).

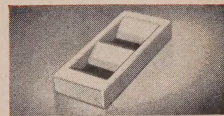
POWERTRON HAS COMPLETELY AC POWER SUPPLY



Transistorized Model has rectifier and filter in power supply—not in amplifier, where servicing is difficult. No batteries. Costs 27¢ to operate for full year. Battery types require \$5 to \$9 in batteries a year to operate continuously at maximum efficiency.



ONLY POWERTRON HAS RANGE CONTROL SWITCH TO PREVENT OVER-DRIVING TV SETS ON EXTRA STRONG CHANNELS.



ONLY POWERTRON HAS AC PLUG-IN OUTLET FOR TV SET BUILT INTO THE POWER SUPPLY.

POWERTRON IS 100% CORROSION-PROOFED—ANTENNA IS GOLD ANODIZED, ALL HARDWARE IRRIDIZED, AMPLIFIER HOUSING OF HIGH IMPACT PLASTIC.

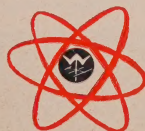
ONLY THE POWERTRON CAN DO ALL THIS!

1. Powertron will drive up to 10 TV sets and each set will have a better picture than an ordinary antenna will deliver to one set.
2. Powertron will drive a TV signal through one-half mile of lead-in with signal to spare—permits you unprecedented flexibility for remote installations.
3. Powertron will virtually eliminate snow and interference even on an old TV set.
4. Powertron will deliver superlative color reception far better than a non-electronic antenna.
5. Powertron brings in stations beyond the reach of non-electronic antennas—delivers greatest reception distance.



AND WINEGARD POWERTRON is the only antenna presold to your customers—nationally advertised in the biggest consumer advertising campaign yet! So stock up now—take advantage of the demand Winegard is building for you.

Write for free technical bulletins.



Winegard

ANTENNA SYSTEMS
Winegard Co., 3013-12 Kirkwood, Burlington, Iowa

Sporadic-E Opens New Horizons (Leinweber)	Oct	104
Snitcher, One-Transistor (NC)	Jan	114
Special-Services Receiver (Queens)*	Feb	82
Stations, Silicon Rectifiers Replace Tube Types in Transmitters at (NB)	Oct	16
Telescope to Stud Jupiter (NB)	Jun	12
Teletype For Car (NB)	May	14
Transistor		
Circuits, Offbeat (Scott)	Apr	32
Free Power, New and Different (Grace)*	Feb	50
OTL Circuits in (Scott)	Aug	50
Output Circuit (NC)	Sep	116
Service Aids (Finzer)*	Jun	53
Servicing, Circuit Substitution		
Speeds (Borlaug)	Jan	85
Superhet in Headphone (de la Roza)*	Sep	44
Superhet, Regenerative (NC)	Mar	118
Thermogenerator, Kerosene, Powers (NB)	Sep	6
Underground, Sets Record (NB)	Jan	6
Waveguides, Earth Has Magnetic (NB)	Apr	8
WWV Sets Its Clock Back (NB)	Mar	12
Rally-Pal Computer (Corr)	Jan	128
Relay(s)		
Ac-Dc, Heavy-Duty	May	100
Circuit, Pat	Jun	103
Composite-Transistor	Jun	61
Evolution in	Feb	45
5-μs (Patrick)*	Dec	74
Impulse, Improvised (NC)	Oct	128
Industrial (see Industrial Electronics)		
Quillator Drivers (Pasch)	Feb	45
Photoelectric (NC)	Sep	117
Service Note (Patenberg)	Oct	76
Time-Delay Simplified (Hamilton)	Apr	51
Remote Control		
Lawnmower, Automated (Carlson)*	Apr	35
Television, One-Tube (Sylvania) (De Marinis)	Feb	56
Reverberation Enhances Hi-fi Audio (Scott)	Dec	36

S

Scopes—See Test Instruments		
Semiconductors—See also Transistors, Zener		
Diodes, etc		
Diamond (NB)	Nov	6
Diodes		
Do It With (Stoner)	Feb	38
4-Layer, and Controlled Rectifiers;		
What Are They? (Jackson)	May	44
Gallium Arsenide Phototube Highly		
Sensitive (NB)	Oct	8
Ift New Solid-State (NB)	Sep	8
Nuvistor Triode, TV Tuner Uses	Feb	72
Silicon Rectifiers Replace Tube Types		
in Transmitters (NB)	Oct	16
Solid-State Device, New, Rivals Tunnel		
Diode (NB)	Jan	12
Speciator, Improved (Pat)	Sep	120
Shooting Gallery, Electronic (Piffet)*	Dec	50
Single-Curve Chart (Thiersch)	Jan	95
Speakers—See Audio-High Fidelity Stereo		
Stereo Multiplex—See FM		
Strain Gauges, What They Can Do		
(Kramer)	Jan	64
Sweep Generator—See Test Instruments		
Sync Separators and Clippers (Darr)	Feb	86;
	Mar	89

SERVICING

Alarm for High Voltage (TTO)	Jan	116
AUDIO SERVICING		
Fuse Blows (Telefunken Stereo 5083-WK)		
(Tech)	Jun	90
Phono Picks Up FM Station (Mark II	Jan	107
Realist) (Tech)		
Records and Record Players		
Noise Less, More Poise (TTO)	Oct	130
Turntable Slip (TTO)	Apr	84
Signal Coupling (Allied 83 z 774)		
(Tech)	Dec	119
Tape Spills (Steelman Transipaste and		
Airline 7111-M) (Tech)	Nov	129
Tape and Tape Recorders		
Noise On Tape (Steelman Transipaste and		
Airline 7111-A) (Tech)	Jul	89
Pressure Rollers, Clean (TTO)	Jun	98
Servicing (Darr)	Sep	58
Brakes and Pressure Pads	Jan	56
Level Indicators and Tape Erasing		
Mikes, Amplifiers, Bias-Erase	May	47
Oscillators	Jul	78
Recording Head		
Switching—Electronic and	Aug	39
Mechanical	Sep	115
Sound Interment and Noisy (Crestwood		
CP-201) (Tech)	Oct	92
Take Up Reel Inoperative (Steelman		
Transipaste and Airline 7111M	Jul	18;
(Tech)	Jun	56; Jul 78; Aug 39;
Tape Recorders (Darr)	May	47;
	Sep	59;
	Oct	122
Ticks (Tech)	Dec	38
Bench, New Thought in (Shunaman)	Jun	90
Capacitors, Clues for Checking (Tech)		
Gears, Reassembling Spring-Loaded	Oct	62
(Tech)	Feb	116
Line Cord, New (TTO)	Mar	26;
Parts Rack (Corres) (TTO)	Oct	131
Phono-Plug Handle (TTO)	Oct	93
Power Transformers, Checking (COHN)	Jul	37
Printed Circuits		
Desoldering (Kaufman)	Apr	52
Tips (Tech)	Nov	129

Public-Address Speakers Full of Birds'

Nests (Tech)	Sep	114
RADIO(s) SERVICING		
Alignment (Tech)	May	97
Antenna, Automatic Repair (Lincolns)	Apr	94
(Tech)		
Automobile		
Antenna, Inoperative Powered (Tech)	Sep	114
Cuts Out Intermittently (Ford M-4)		
(Tech)	Jun	91
High-Frequencies Lost (Chevrolet	Jul	88
987891) (Tech)	Aug	36
Noise, Stop (Lemons)	Jun	107
Output Distorted (Philo) (Tech)	Oct	122
Polarity of 12-Volt Input (Ford 67MF)	Oct	122
(Tech)		
Speaker Terminals Floating (Tech)	Oct	122
Transportable Dead In Car		
(Oldsmobile) (Tech)	Jan	107
Battery, Repair Rechargeable (TTO)	Apr	84
Dropping Resistor (Gosnet G-12) (Tech)	Nov	128
Hum (Espey 511-B AM-FM) (Tech)	Jan	104
Intermittent (6-X-5) (Tech)	Apr	96
Motorboating (Transalor 8706) (Tech)	Feb	100
Performance, Improving Receiver and		
Transmitter (NC)	Dec	106
Shorts, Clearing Variable-Capacitor		
(TTO)	Sep	119
Sound Distorted (Philo T7) (Tech)	May	97
Sound Erratic and Poor (G-E 575) (Tech)	Jun	89
Squealing (RCA 8-BT-7, -8) (Tech)	Aug	92
Transformers 9-meter for service (Tech)	Aug	92
Transistor		
Current Drains (Tech)	May	97
Service Aids For (Finzer)*	Jun	53
Tricks, Basic (Eslick)	May	76
Trouble Chart 1 (Leslie)	Nov	50; 11
(D'Alro)	Dec	48
Rectifier, Scope Checks (Tech)	May	98
Relay(s)		
Industrial—See Industrial Electronics		
Service Note (Patenberg)	Oct	76
Speaker, Protect (TTO)	Jul	94
Soldering		
Second Solder (TTO)	Jun	98
Aluminum (TTO)	Jul	94
Technician's Guide to Good		
(McMurry)	Nov	40
Teflon Is Safe (Corres)	Mar	22
TELEVISION SERVICING		
1X2 Breakdown (RCA CT-1708) (CI)	Sep	88
1B3 Failure (Motorola T553) (Tech)	Mar	99
6B6 Failure (Capehart 3006 MP) (CI)	Aug	56
Apac Faulty (RCA 2-6082) (CI)	May	64
Auto-Conditioned (TTO)	May	67
Alignment, Signal Generators In (CI)	Mar	60;
(Corres)	May	18
Amplifier Circuit Quirk (Heathkit EA-1)	Feb	101
(Tech)		
Analyst Simplifies Servicing (B&K Analyst)	Jul	34
(Lemons)		
Antenna		
Alignment (TTO)	Feb	116
Coil or RF Amplifier? (Citron)	Sep	52
Coupling (CI)	Mar	66
Don't Forget (Cunningham)	Jun	34
Installation (Tech)	Feb	100
Standoff Mount (TTO)	Apr	84
Temporary (TTO)	Jul	94
Arcing, High-Voltage (Tech)	May	98
Autodyne Converter Troubles		
(Philpott)	Sep	57
Bonding Straps (TTO)	Jan	126
Boost Voltage None (Bendix 2070U)		
(CI)	Jun	81
Brightness Control Band (RCA KCS-82)		
(CI)	Jul	62
Brightness Out (Admiral 21D1) (CI)	May	61
Buzz (GE-M5) (Tech)	Feb	100; RCA 17-S
Dec 112)		
During Warmup, (Admiral 21E3Z)		
(CI)	Mar	64
Color		
Blooming Red (RCA 21CD8845) (CI)	Feb	62
Degaussing Coil, Make (Tech)	Apr	94
Don't Be Afraid (Darr)	Nov	35
Drift (Admiral 322C2) (CI)	Dec	61
Focus Drift (RCA CTC-5) (Tech)	Oct	122
Focus Out (RCA 800 Series) (Tech)	Sep	114
Herringbone (RCA CT660U) (CI)	Mar	61
Interference (RCA KCS-81A) (CI)	Nov	64
Shading (RA 21CD7000) (Tech)	Jan	104
Compression, Black or White		
Conversion		
Color (CI)	May	61
G-E 21T25 (CI)	Dec	67
Philharmonic 8820 (CI)	Sep	88
RCA KCS 47-A (CI)	Mar	66
RCA 630 (CI)	Jul	81
Sentinal 411 (CI)	Feb	63
Separation 265570 (CI)	Apr	64
Zenith 2438RZ1 (CI)	Aug	56
Zenith 24H21 (CI)	Oct	70
CRT Check (Tech)	Jan	98
Curious Trouble (Titmus)	Mar	71
De-Rectifier		
Adding (Stromberg-Carlson 21CM2)		
(CI)	Aug	56
Installing (Hotpoint 21S505) (CI)	Mar	67
Do-It-Yourselfers, Handling (Darr)	Jul	33
Don't Do Half a Job (Davis)	Oct	40
Drive Line (G-E 21C40)	May	64
(528.63-1) (CI)	Feb	101
Dual-Diodes, Identifying (G-E) (Tech)	Dec	61
Electronics (CI)		
Fluorescent		
Burned Out (Mathison 630DXM) (CI)	Feb	62
Replacement (Fada S-100D) (CI)	Mar	66

Frequency Response		
Fuse Blows (Phillips 3550) (CI)	Nov	64
KCS107-B) (Tech)	Oct	123
Height Poor (Crosley 11-451VW) (CI)	Oct	69
High Voltage (Motorola 21K16TV) (Corres)		
Nov 18; (RCA KCS89E) (CI)	Feb	68
Hint (Tech)	Mar	98
Lucky Hunts Low (Lemons)	May	92
Horizontal		
Hold (Magnavox U24-04AA) (CI)	Feb	63;
Motorola TS-542) (Tech)	Jul	100;
Oscillator Drift, Stop (Lemons)	Oct	50
Output Tube Cathode Current		
Measuring (RCA CTC-5		
CTSCN) (Tech)	Jul	88
Phasing Bad (Philo 49-1150) (CI)	Jun	81
Shadows (1930 Techmaster) (CI)	Feb	63
Shrinkage (Philo 9136) (Tech)	Sep	115;
(RCA 21T176) (CI)	Apr	64
Sync (Philo 7640) Jun 90; (Tech) (Zenith		
231722) (Tech)	Mar	98
Trouble (Philo 50T-1479) (CI)	Nov	65
Wiggling (RCA KCS34C) (CI)	Jul	62
Hum (Sylvania 1-544-3) (Tech)	Jun	91
Inoperative (G-E 14T007) (CI)	Feb	63
Inoperative (Hoffman 145703) (CI)	Feb	63
Interlace—Cy and Lucky Get Jitters		
(Lemons)	Nov	102
Intermittent, Cy and Lucky Whip		
(Lemons)	Sep	76
Interference (CI)	Jul	63
Ion Burns (DuMont RA-110) (CI)	Nov	64
Ion Trap Misplaced? (CI)	Sep	85
Keystoning (Bendix FM 27C) (Tech)	Jan	107
Linearity		
Linearity Coil Hot (Hoffman 21M115)		
(CI)	Oct	70
Marginal Performance (CI)	Jul	60
Markers Meet In Middle (RCA) (CI)	Mar	66
Oscillator Intermittent (Canadian		
G-E 21C30) (CI)	Feb	63
Picture		
Detail Poor (Raytheon 17AY21) (CI)	Oct	70
Load (Holtz)	May	39
Picture-Tube Troubles (CI)	Aug	52
Quality Control (NC)	Nov	138
S-Bend (Philo 7420) (CI)	Jun	81
Weak (Admiral 16B11) (CI)	Apr	65;
(Philo 22CA312) (CI)	Feb	68
Prices		
Raster		
Bloom (Motorola TS-542) (Tech)	Jun	91
None (Westinghouse H147171) (CI)	May	60
on Strong Stations (Westinghouse		
V-2192) (CI)	Oct	70
Rectifier Headaches (CI)	Aug	56
Remote Control (Hoffman) (Tech)	Apr	94
(Hoffman) (Tech)	Nov	64
Retrace Line(s) Intermittent (Packard-		
Bell (CI) Sep 88; (Philo) (CI)	Apr	64
RF Amplifier or Antenna Coil (Citron)	Sep	52
Ribbon Lead, Stripping (Linton)	Apr	71;
(Corres)	Jul	22
Secret Signals on Screen (Carlson	Nov	87
Stacked-B Circuits (Darr)	May	67
Stacked-B Trouble (Shaw)	Jun	33
Snow (Philo UE 42005) (CI)	Aug	53
In If (Wayne)	Dec	51
Sound		
Bounce (Motorola, Canadian) (CI)	Jun	81
Distorted (RCA 8BT-10K) (Tech)	May	98
Intermittent (RCA KCS120) (CI)	Sep	88
Intermittent or Out (Hoffman 331)		
(Tech)	Jan	104
Loud (Admiral 18Y4KS) (CI)	Feb	62
Noise Immunity Poor (1955 Fleetwood)		
(CI) (Tech)	May	64
Poor (Hyde-Park C11) (CI)	Aug	53
Sound and Picture		
None (Hoffman 175) (Titmus)	Jun	71
Out (Zenith 21816C) (Tech)	Apr	96
Sweep Alignment (CI)	Dec	64
Sync Separators and Clippers (Darr)	Feb	86;
	Mar	89
Tube		
Burnout Chronic (Sylvania 1-512-1-2)		
(CI)	Oct	70
Changes, Watch, Those (CI)	Feb	61
Filaments (CI)	Jul	59
Heaters (CI)	Jul	59
Tuner(s)		
Care and Repair (Randall)	Jul	51
Cascade Circuits (CI)	May	60
Cleaning (CI)	Sep	84
Chords (Corres)	Mar	38
Don't Let It Throw You (Davis)	Aug	10
Drift (CI)	Sep	88
FM Problem (Burststein)	Dec	72
If Lower? (CI)	May	65
Replacement (Dumont RA-117A) (CI)	Feb	62;
(Philo 53-T-1883) (CI)	Oct	68
Twin-Lead, Stripping (WN)	Oct	53
Vertical		
Amplitude (Muntz M 32) (Corres)	Jan	22
Bars (Emerson 120245D) (CI)	Dec	66
Deflection (RCA 171721C) (CI)	Dec	117
Distortion (Crosley H-21COWUc) (CI)	Sep	85
Drifting and Dreaming, Peeve's		
(Wayne)	Aug	61
Foldover Problems (Lemons)	Sep	54
Height Loss (Motorola TS-60) (CI)	Jul	62
Hold Critical (Motorola TS-542) (Tech)	Feb	100
Hold Weak (Zenith 19R21) (CI)	Feb	62
Intermittent (Crosley 426) (CI)	Mar	61

WORTH SHOUTING ABOUT!

NEW IMPROVED
MIGHTY MITE

Reaching New Peaks in
Performance, Portability and Price

MIGHTY MITE II

They're shouting from the hill tops. Technicians, engineers and test labs all say that the original Mighty Mite finds the tubes that large expensive testers miss. And now . . . here is the new improved Mighty Mite! Designed for the present and far into the future. Tests all of your present tubes plus the new RCA Nuvisitors and Novars, GE Compactrons and Sylvania 10 pin tubes.

A complete tube tester that is smaller than a portable typewriter yet outperforms testers costing hundreds of dollars. A real money maker for the serviceman and a trusty companion for engineers, maintenance men and experimenters.

Even though the Mighty Mite weighs less than 8 pounds, new circuitry by Sencore enables you to use a meter to check grid leakage as high as 100 megohms and gas conditions that cause as little as one half microamp of grid current to flow. Then too, it checks for emission at operating levels and shorts or leakage up to 120,000 ohms between all elements. This analytical "stethoscope" approach finds troublesome tubes even when large mutual conductance testers fail. And it does all this by merely setting four controls labeled A, B, C, & D.

Check these plus Sencore features: Meter glows in dark for easy reading behind TV set • Stainless steel mirror in ad-



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DEALER NET

Remember . . . there is
only one Mighty Mite

justable cover for TV adjustments • Rugged, all steel carrying case and easy grip handle • Smallest complete tester made, less than one foot square. Mighty Mite II will test every standard radio and TV tube that you encounter, nearly 2000 in all, including foreign, five star, auto radio tubes (without damage) plus the new GE Compactrons, RCA Nuvisitors and Novars and Sylvania 10 pin tubes.

Mighty Mite II also has larger, easy-to-read type in the set-up booklet to insure faster testing. Why don't you join the thousands of servicemen, engineers, and technicians who now own a Mighty Mite tube tester? Tube substitution is becoming impossible and costly with nearly 2000 tubes in use today. Ask your authorized Sencore Distributor for the New Improved Mighty Mite. Size: 10¼" x 9¼" x 3½" Wt. 8 lbs.

MODEL TC114

Sencore Sam says . . . "They all agree . . .
the Mighty Mite is the real answer for the man on the go."



SENCORE ADDISON, ILLINOIS

Linearity Poor (Zeni-Tone TV-208) (CI)	May	61	Nuistor Triode, Uses	Feb	72	Electronic Monitor Is Wide-Range		
Output Tube Red-Hot (Philco 52T120) (CI)	Sep	115	Transistor, New, What Makes Them Tick? (Lucas)	Apr 44; May	37	(Wrigley)*	Aug	74
Retrace Eliminator (Philco 52-T1240) (CI)	Aug	53	UHF Experimental, FCC Will Construct (NB)	Mar	10	Transistor(s)	May	14
Rolling (G-E 810) (CI) Dec 66; (Motorola IOWT10R) (CI)	Oct	69	FCC Asks for All TV's (NB)	May	14	5-Gigacycle (NB)	Oct	110
Shrinkage (G-E 21C1550) (CI)	May	64	Ultraviolet Now Used for Communications (NB)	Mar	6	Bias Regulator (Taylor)	Jan	181
Stretch (Philco 276800) (CI)	Aug	56	(NB)	Jun	93	Compensation of Parallel (Pat)	Jun	55
Troubles (Raytheon 14AX21) (CI)	Nov	59	Viewer, Individual (Pat)	Jun	29	In Parallel (Taylor)	Jan	58
Transformers q-meter for Service (Tech)	Aug	92	Voltmeter, Can't Burn Out (Bartholomew)	Aug	29	MADT, High-Power, Making	Jun	26
Video and Sound Out (RCA KCS81-A) (Tech)	Nov	128	Watchdog	Sep	55	Myth, Exploding	Jul 28; (Corres)	Sep 26
Video Whiteout (Philco 7170) (CI)	Nov	128	TEST INSTRUMENTS AND CIRCUITS			New, Has Gain of 30,000 (Garner)	Jun	59
White Streaking (G-E M4) (CI)	Dec	67	Capacitor Analyzer, Low-Voltage (Sprague TCA-1) (Lemons)	Aug	80	Radios—see Radios	Mar	115
Width Circuits (CI) Oct 68; (CI) Nov 59	Nov	59	Capacitor Checker, Modification (Conaut) (Corres)	Jan	20	Rectifier (Pat)	Dec	40
Width Excessive (1960 Hoffmans) (Tech)	Aug	56	CRT Checker (Tech)	Mar	98	Roundup (Spencer)	Nov	42
Wideband Replacement (Trio TV) (CI)	Jun	81	CRT Substitution Speeds Transistor Radio Servicing (Borlaug)	Jan	85	Silicon Star Heart of (WN)	Oct	75
TEST INSTRUMENT(S) SERVICING (See also Test Instruments)			Citizens-Radio Test Set, New (Crystallign-meter) (Scott)	Feb	54	Testing In-Circuit (Sencore TR110 and Ultraminutaria) (NB)	Sep	66
Scope			Continuity Checker, Billion-Ohm (Lipiner)*	May	66	Universal (WN)	Nov	42
Deflection (Heath OM-1) (Tech)	Nov	128	Decade Boxes, Improvement For (Arditti)	Nov	74	Transione Locates Hidden Wiring (Parker)* (Corr)	Jan	117
Focus, Drift, What T25 (Tech)	Jul	99	Dip Tunnel-Diode (Turner)*	Nov	72	Translators See Television		
Horizontal Sweep Inoperative (Tech)	Mar	99	Electrolytic?, How Good Is That (Reed) (Corres)	Jul 73; Nov 22	Jun 93	Troubleshooting Power Supplies With Scope (Middleton)	Apr	48
Intensity Control (Precise 300) (Tech)	Feb	101	Frequency Meter (Pat)	Nov	74	Tunnel Diodes		
Vertical Deflection (Heath OM-1) (Tech)	May	97	Gain Checker Transistor (NC)	Apr	42	Care and Handling (Turner)	May	88
Timer, Watchmaster, Erratic (Tech)	Aug	92	Horizon Sweep Analyzer (Lemons)	Jun	114	Self-State Device, New, Rivals (NB)	Jan	95
Transistor(s)			Light Level Indicator (Reed)* (Corres)	Nov	18	Looseener	Jul	93
Handling Hints (Patrick)	Jun	55	Light (Jul) (Corres)	Jun	78	Oscillator Hint	Jul	93
Heat Dissipation (Corres)	Feb	20	Logarithmic Converter (Rhita)	Nov	20	Panel Bearings, Inexpensive	Mar	123
Sonar Works, How (Glennan)	Oct	34	Meter	Dec	117	Parts Holder, Handy	Sep	18
Sound Systems in Schools and Industry (Johnson)	Sep	38	Cam-Angle (Tech)	May	16	Parts Rack, Hickok 890	Oct	131
Space-Scanning Antenna Multipolarized Strain Gauges, What They Can Do (Kramer)	Jan	64	Make It Easier To Read (Sands)	Feb	74	Phono-Plug Handle	Jul	93
Strobe Instrument Tunes Organs (Dorf)	Feb	42	New Idea in (WN)	Oct	53	Potentiometer Calibration	Jun	97
Superscopes, About These (Jaski)	Mar	68	Milliammeter, Wide-Range (NC)	Aug	88	Radio Battery, Repair Rechargeable	Apr	84
Swinging Chokes to Magnetic Amplifiers (Mandl)	Nov	52	Missing Spot, Case of (Karrol)	Mar	92	Recap, Reflecting	Aug	97
T			Modulation Monitor Checks CB Transmitters (Green)	May	53	Rectifier, Silicon Replace Selenium	Jun	97
Technician of Month W. D. Ludwick (Cornish)	Jul	55	Multimeter, Safeguard (TTO)	Oct	132	Solar-Cell Precaution	Mar	123
Technician's Guide To Good Soldering (McMurray)	Nov	40	Multivibrator	Mar	117	Solder(Iron)	Feb	117
TELEVISION			From Single Pulse (NC)	Nov	48	Flux-Can Handle	Apr	85
Antenna			Transistor, Has Crystal Control (Queen)*	Nov	48	Television	Aug	97
Integrated (Darr)	Oct	90	Multimeter, Full Value From (Kemp)	Jul	103	Air-Conditioned	Aug	97
New "Magic" (TTO)	Jan	116	Noise Generator (Pat)	Mar	73	Alignment	Feb	116
Battery (NB)	Oct	16	Oscillator	Apr	74	New "Magic"	Jan	116
EBB Raps Set Manufacturers	Mar	44	2-Terminal (Queen)	May	74	Temporary	Jul	94
Booster Deadline Extended by FCC (NB)	Apr	6	Crystal Beatnik (Queen)*	Apr	74	Bonding Strap	Mar	124
Camera, Transistorized Image Orthicon Sensitive (NB)	Oct	18	Picture Indicator (Pat)	Apr	67	Loaner Builds Business	Jun	98
Channel Allocation, FCC Moves on (NB)	Oct	10	Picture-Tube Brighteners (Goldstein)	Jan	126	Pix On Scope	May	107
Circuits, Two New (RCA KC531 and KC5132) (Lemons)	Oct	46	Prod Handling, Clothespin Eases (TTO)	Apr	90	Standoff Mount	Apr	84
City Guide for Tourists (NB)	Oct	16	Pulse Indicator (Pat)	Jan	90	Terminal Connections, Betles	Aug	97
Closed-Circuit, Safe Driving With (Von Ardenne)	Feb	80	Scope(s)	Jul	68	Multimeter Safeguard	Oct	132
Close-up Listening (NC)	Dec	99	Calibrator for (Shaughnessy)*	Jul	68	Prod Handling, Clothespin Eases	Mar	126
Color			Full Value From (Kemp)	Dec	58	Prod Tips, Dip	Nov	34
Accelerates (NB)	Jun	6	In Electronics (Middleton)	Aug	70	Prod Rivets Improve Tips	Nov	136
Banana Tube (NB) Oct 6; (Leslie)	Dec	39	Nonlinearity (CL)	Apr	64	Third Hand	Sep	119
Canada, Not for (NB)	Jan	10	Pilot Light (Scheckley)	Sep	46	Transistor		
Flat Needed? (NB)	Sep	10	Portable Test Transistorized (Jaski)	Jan	55	Battery Terminals, Save	Nov	135
Good News (NB)	Aug	6	Smaller (Jaski)	Nov	100	Connections, Heatless	Oct	130
More Companies in (NB)	Jun	6	Super-Scopes, About (Jaski)	Mar	68	Radio Transistor Power Supply	Nov	134
System, New, May Help Small Stations (NB)	May	6	System Phasing	Aug	68	Reamer Stop, Solder Makes	Sep	118
Tube Brighter (NB)	May	6	TV Fix on (TTO)	May	107	Screwdriver Modification	Jan	117
Tube, New Japanese? (NB)	Nov	10	Trouble Chart	Mar	92	Solder	Oct	130
World-Wide At 1964, Says Sarnoff (NB)	May	12	Troubleshooting Power Supplies With (Middleton)	Apr	48	Work Table Atop Solder Spool	Nov	135
Zenith Will Make (NB)	May	14	Signal Generator	Jun	53	6-Second Solder	Jun	98
Designs For 1961 (Lemons)	Jan	42	Transistor Radio Service Old (Finzer)	Jun	53	Aluminum	Jul	94
Educational—see Education			RI Calibrate Your (Smith)	Oct	56	Gun Sander, Carries Own	Jan	117
FM Tuner, Add TV Sound To (Maggi)	Nov	58	RI Covers Marine Bands (Stone)*	Oct	56	Iron Carries Own Solder	Jul	95
Interference, FCC Cracks Down on Owners "Line-Of-Sight" 136 Miles	Oct	49	TV Alignment (CL)	Mar	60	Storage	Aug	97
Modulator, Crystal Diode (NB)	Oct	49	Square-Wave Generator (Pat)	Oct	103	Speaker, Save The	Jul	94
Moon, Pix to Come From (NB)	May	6	Squaring Circuit (NC)	Apr	107	Transistor(s)	Mar	125
Nuclear Coming? (NB)	Oct	6	Speaker, Test, Speeds Industrial Repairs (Kernin)*	Feb	93	Connectors	Jul	95
Pay, in Little Rock Ark. (NB)	Sep	6	Sweep Analyzer, Top-Chassis Horizontal (Lemons)*	Feb	34	Heat-Sink Insulator	Mar	123
Pay, Postponed (NB)	Nov	6	Sweep Generator	Jul	39	Using Discard	Nov	134
Picture-Tube Brighteners, Using (Goldstein)	Apr	67	Troubleshooting (Anderson)	Mar	40	Vise, Toolbox-Top	Mar	123
Radiation-Limits Seal Visible (NB)	Oct	38	Wobbling (Wilner)*	Nov	138	Vise, Universal	Feb	117
Remember (Rupp)	Oct	33	Wobbling Improved (NC)	Oct	77	Wrench Thumbscrew	Jan	117
Remote Control			Switch Electronic Repeating (Wilensky)	Oct	128	U		
Magnetic Field for (Pat)	Nov	137	Scope, Sweep Improvement, Triggered (NC)	Sep	68	Ultra-Kap? Do You Know (Centralab) (Corres)	Jan	60;
One-Tube (Sylvania) (DeMariis)	Feb	56	Tape-Speed Test Loop (Stone)	Feb	93	Ultrasonic(s)	Jun	8
Ultrasonics Control	Jul	46	Test Speaker Speeds Industrial Repairs (Kernin)*	Nov	138	At UHF (NB)	Jul	46
Satellite, RCA Smalls (NB)	Jul	8	Transformers in live, plus (White)	Jan	54	Controls Air Condition (Maxwell)	Oct	10
Screen, Small (NB)	Oct	6	Transformer Tester, If (NC)	Nov	138	Delay Line Works With Light at Vhf (NB)	Feb	10
Set Shortage Coming? (NB)	Aug	34	Transmitter Testers, New CB (Lemons)	Dec	77	"Sews" Plastics (NB)	Oct	8
Sound Interrupter Has Only 4 Parts (McGready)*	Feb	86;	Transistors	Jan	8	Soldering (Pat)	Feb	102
Sync Separators and Clippers (Darr)	Feb	89	In Parallel-T (Taylor)	Sep	66	V		
UHF, All in 5 to 7 Years? (NB)	Feb	6	Testing In-Circuit (Sencore TR110 and Hickok 890)	Oct	75	Variation Control For Automation (Maudl)	Sep	94
Translator(s)			Transistor Tester	Oct	75	Vhf		
Authorization Fact Sheet	Mar	53	Speedy	Oct	75	Amplifiers, Aligning Wide-Band (Beever)	Jan	50
Vhf, For Your Town (Freen)	Mar	42	Radio Service Aid (Finzer)	Jan	54	Translator Tv For Your Town (Freen)	Mar	42
Vhf, Start Work (NB)	May	6	Tube Checkers, 2 Miniature (B&K 600; Sencore TC109 Mighty Mite) (Lemons)	Jun	66	Vivm—see Test Instruments		
Tube			Ultra-Kap?, Do You Know (Centralab) (Corres)	Jan	60;	Volume Regulator, Protect That	Jan	59
Banana (NB) Oct 6; (Leslie)	Dec	39	Voltage Control Box Simple (Fred)	Mar	18	V-R Tube Current, Measure (Kaping)	Jan	50
Fiber Optics in New CRT	Oct	52	Voltage Regulator, Zener Diode (Lederer)*	Dec	56	W		
Flat, New? (NB)	Jun	10	Vivm Wide-Band, Doubles As Audio Analyzer (Walter)*	Mar	40	Wartime Inventors, Credit to (Meissner)	Jul	45
Pins To Stay Soldered (NB)	Aug	12	Waveform Gen (NC)	Oct	128	Watch Demagnetizer	Aug	80
Tuner(s)			Zener Diodes Simplified (Stoner)	Jan 32; (Corres)	22	Wide-Band Vhf Amplifiers, Aligning (Beever)	Mar	50
Care and Repair (Randall)	Jul	51	Timer	Apr 28; Sep 22		Z		
			Electronic (Draw . . . Shoot) (Wortman)	Jun	47	Zener Diode Voltage Calibrator (Lederer)*	Jan	32
						Zener Diodes Simplified (Stoner) (Corres)	Apr 28; Sep 22	